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ABSTRACT

Analysis of demographic, social, municipal and commercial characteristics of Washington, D.C., indicate that a sophisticated three-stage cable television (CATV) system could be economically viable. The first stage would provide one-way CATV service offering 30 video channels and local program origination at a monthly fee of $3.50. The second stage would provide subscribers with low-cost home terminals and a number of two-way home services such as interactive educational and entertainment programs, preference polling, catalog shopping, alarm communications and utility and maintenance services, for a basic monthly fee of $6.50. The third stage, several years away, would provide subscribers with typewriter-like keyboards and local storage devices to permit computer-communications and individualized TV pictures, and would cost considerably more. Market tests indicate that while standard one-way services would be only marginally profitable, two-way services would meet high demand and could provide attractive profits. (MG)

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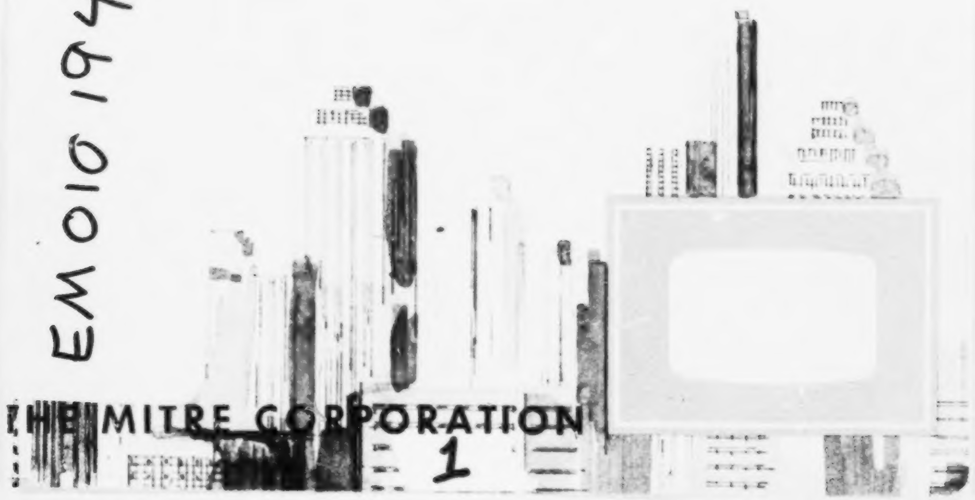

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URBAN
CABLE SYSTEMS

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WASHINGTON OPERATIONS

PREFACE

During the present decade it is expected that cable television systems (CATV) will be franchised and built in most of the cities and metropolitan areas of the nation. Up to now, CATV has served mostly to retransmit over-the-air broadcast signals into small towns and communities.

In this new urban setting, the capabilities of cable can be expanded greatly and applied to important but yet unmet communications needs of our cities and our society. Cable will thus have the opportunity to affect and even transform many features of urban life, but to do this successfully it must itself be transformed. To play its potential role as the cutting edge of the coming communications revolution, cable must outgrow its identity as a simple retransmitter of over-the-air TV signals, and become the medium for delivering a wide range of broadband, two-way communications services to fulfill many of the social, cultural, civic, educational, governmental, business and commercial needs of the city. Introducing this new form of communications into the mainstream of American society in such a way that its promise will not be abridged or underplayed, is one of the most important and complex tasks of the 1970's. This Report provides information and guidance designed to assist cable owners and operators, program groups, government officials, community leaders and civic groups to achieve that goal.

The system design alternatives discussed in this Report are characterized by the needs for high subscriber penetration and low subscriber costs to meet the twin tests of financial viability and social usefulness. Many questions regarding the creation and acceptability of new programming services and the new institutions needed to deliver these services, copyright arrangements, system ownership and operation, regulation, franchise conditions, capitalization and fee structures, and technical design must yet be addressed on an interrelated basis if cable is to achieve its full potential in the city. To provide a forum for discussion of these issues, MITRE plans to sponsor a Symposium in the fall of 1972 in Washington, D.C. with wide industry, government and academic participation.

No study or system design is as informative as a large-scale demonstration. Many system demonstrations and experiments need to be planned and conducted to provide the operational framework necessary for working out the interrelationships of the functions outlined above, especially for the institutions needed to deliver socially useful services. If we are to move ahead now in a calculated way, the support of both private industry and government at all levels will be necessary in undertaking the efforts and the risks involved.

We are especially grateful to The John and Mary R. Markle Foundation for the grant that made it possible to do this comprehensive study in the public interest.

Charles A. Zraket
Senior Vice President

ACKNOWLEDGMENTS

This MITRE work has been enhanced by a number of valuable contributions. Henry Beiman and Rex Klopfenstein were indispensable in their timely manipulation of the economic model. Mollie Harman correlated demographic data of the District of Columbia. Steve Lubore provided the analysis of the Howard University survey data and Lee Afflerbach, Jim Morrell and Walter Nickel analyzed the cable industry's technical capability. We wish to express special appreciation for the typing efforts of the following secretaries: Faye Dunford, Jewell Freeman, Madolynn Legg and Linda Sullivan. Empirical data on cable system techniques and costs were obtained from members of the MITRE staff who are conducting the MITRE interactive television demonstrations in Reston, Virginia.

The consulting firm of JANSKY & BAILEY was involved in the early design of the conventional portions of the Washington, D. C. cable distribution system, headend and studios, during May 1971. Among the JANSKY & BAILEY contributors were Delmer Potts, Oscar Reed, James Reeve, Nugent Sharp, Howard Turnage, and Nicholas Worth. Howard University conducted the marketing survey for the Washington System. The Howard University efforts were managed by Dean M. Wilson and Phillip Clark. RAND made informal contributions to the Interim Report, as referenced therein. We also wish to acknowledge the many informal contributions to the study that have been made by Franz Allina and David Britt of Children's Television Workshop.

Appendix D is a partial list of the many persons and organizations contacted by MITRE during the course of this study.

The MITRE Corporation work presented in this report has been sponsored by The John and Mary R. Markle Foundation.

WFMason

William F. Mason
Project Leader and
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ABSTRACT

Most of today's cable television systems have achieved economic success because they deliver a large selection of over-the-air broadcast TV signals, or at least clearer pictures, in areas where reception is inferior. In most urban areas, however, residents already receive large numbers of TV signals with acceptable clarity. If cable systems are to be viable in these urban areas, they will have to deliver a variety of new and attractive programs and special services to obtain subscribers. Given that cable must be able to provide these programs and services for marketing reasons, it seems reasonable to examine what other non-commercial services and/or benefits one can obtain from such a new kind of communication system.

This report analyzes these possibilities, their operational, technical and economic feasibility, and presents a plan for Washington, D.C. that reflects the potential uses of cable. The system design is based on an analysis of the demographic, social, municipal and commercial characteristics of the District and the types of programming and services that could be provided to meet the needs of the District. A review of hardware, software and programming developments, a market survey, and an extensive financial and economic viability analysis were part of the system design process.

The Washington Cable System (WCS) design that has resulted includes a telecasting cable net and several point-to-point cable nets. The 1,076 street-mile, dual-cable telecasting net would:

- pass all of the 263,000 households in the District of Columbia.
- provide 30 one-way video channels initially, with 34 additional channels available in the future for both one-way and two-way services.
- emphasize local program origination by permitting independent programming in local studios to serve neighborhood needs and interests.
- provide two-way communications on a demonstration basis beginning in the first year of operation, with two-way services extended throughout the District in the future.

The point-to-point network would handle two-way video, voice and data communications among Federal and municipal facilities (including hospitals, fire stations and police precincts), colleges and universities, public schools, and major business and commercial interests. The system construction would be phased over a five year period.

Some of the capabilities that the system will provide will not be realized immediately, and this report presents both the basic system design and two higher levels of service which will evolve later. The three levels are referred to as: (1) One-Way transmission, (2) Subscriber-Response or polling capability and (3) Electronic Information-Handling or the capability to display individualized TV frames.

The WCS design provides for more one-way channels, and more services on these channels, than are offered by systems in operation today. These new services will require the development of new program materials and new ideas for using these channels, to support the variety of social needs and interests of urban populations. This report includes plans for generating the necessary funds for such program development, and for the organizational and institutional arrangements that will have to be made to take advantage of the new health, education, law enforcement, etc. capabilities that will be provided.

The system would charge subscribers \$3.50 per month for 30-channel one-way video services, some 30 percent below the typical \$5.00 per month charge for conventional, 12-channel, one-way systems with far more limited cable television services.

The design provides for evolvement into a two-way capability, in which subscribers are able to use push buttons located in their homes, to respond to questions presented on the TV set. A new family of service concepts must be developed to take advantage of the two-way communications capability. The subscriber fee of \$3.50 per month would be raised to \$6.50 per month when the subscriber response services are added.

The third level of service, called Electronic Information-Handling would allow home viewers to use complete typewriter-like keyboards to communicate with computers, with the system control center, with each other, and possibly with government and commercial institutions.

This report summarizes some suggested uses, recommends demonstrations and suggests plans for financing, implementation and operation of the above systems.

The system has been designed to feed back a portion of its revenues for programming expenses. Nine local-community public-access studios would be situated throughout the city, as well as mobile program origination capabilities for on-the-spot program generation. Free channels and large numbers of leased channels would be allocated for public service uses. In the early years, thousands of free home terminals for large-scale two-way experiments in subscribers' homes would be provided. After the demonstration phase, the system would provide two-way terminals and amortize their cost as part of system expenses. The system is also designed to provide a number of revenue-producing municipal and public utility services.

MITRE's analyses indicate that One-Way cable systems, operating in urban centers that already have good over-the-air reception, can be expected to be only marginally viable, even with innovative one-way programming and the recent relaxation of FCC's restrictions on distant signal importation into major markets.

The capital investment required for a Subscriber-Response capability would be about twice that needed for a One-Way System. However, projections of the financial rate-of-return that might be realized with a Subscriber-Response capability are encouraging. Field testing and market surveys of these new and untried services are strongly recommended. Subscriber-Response systems appear to offer the promise of many new and attractive communication services for urban areas in the near term (within five years).

Electronic Information Handling would require significantly more complex and costly equipment, both at the home terminal and at the programming source. The capital investment required would be about four times that needed for a One-Way System. However, the range and value of the services that could be provided are dramatically increased. Such a system could not be implemented in the near term because of the time-consuming requirements for development of hardware, software, and program content. More exact plans for implementation would depend upon the outcome of experiments, demonstrations and market surveys of the programming and services that might be provided. MITRE recommends that the Electronic Information Handling experiments, demonstrations and market surveys be initiated in parallel with, or as soon as possible after, the Subscriber Response experiments.

The introduction of cable systems into urban centers throughout the country will require dedicated work by municipal officials. This report identifies some of the major issues and presents alternatives in terms of the functional, technical, financial and total system options available.

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SECTION I

WIRING THE NATION'S CITIES

THE CONTEXT OF THE REPORT

Community Antenna Television (CATV) originated in the mountainous areas of Pennsylvania and Oregon in the late 1940s, for the limited purpose of providing more and better quality off-the-air TV broadcast signals for the smaller towns and communities of those areas. The CATV industry has grown rapidly, but most of this growth has occurred outside major metropolitan areas, and until now the retransmission of over-the-air broadcast signals has remained the principal function of cable systems. Cable's ability to perform a far broader range of functions is recognized, but these added functions have not yet been put to the twin tests of social usefulness and financial viability. During the present decade, however, it is expected that cable systems will be franchised and built to provide a wide variety of new types of telecommunications services in many major cities and metropolitan areas. When urban centers are cabled and interconnections among urban cable systems have been established by satellite and microwave links, the wired nation will become a reality.

Metropolitan centers differ in important ways from the less urbanized settings where cable originally grew and prospered. These differences include:

- the existence of competing, high-quality off-the-air TV broadcast signals;

- the greater diversity of the characteristics and needs of urban populations;
- the existence within cities of a variety of communities of interest, many of substantial size, many having populations greater than the entire population of towns and communities in which most cable systems have thus far been built;
- the wide range of business, governmental, social, civic, cultural, health, and educational activities in urban centers;
- the scale and complexity of growing urban needs in such fields as public safety, health services, employment, transportation, education, delivery of government services, communications between and among citizens, and communication between citizens and government;
- the likelihood of far heavier demand for cable channels, for specialized programming, and for sophisticated services such as two-way communications and data transmission.

A new generation of cable systems will be developed in response to these characteristics. These new systems will have an impact on the way in which many municipal services will be delivered and on many features of urban society and urban life. These new systems will differ in many basic respects from those in operation today.

First, they will have more capacity, flexibility, and technical sophistication. Urban cable systems must be able to transmit a large number of channels, if future options are not to be foreclosed by technical limitations.

Second, they will deliver many more types of programs and services than cable systems deliver today. Most of these programs and services do not yet exist, or have, as yet, been the subject of only limited experiments. Entire new categories of uses will therefore have to be demonstrated and tested. Ones that are found successful will be added to the inventory of functions that broadband communications will perform in our society.

Third, the economics of building and operating these communications superhighways will bear little resemblance to the economics of building and operating the type of cable system functioning in most U. S. communities today. On one hand, the cost of cable installation in urban centers is far higher than for smaller communities, and additional costs are incurred in providing special terminal equipment to subscribers to enable them to receive sophisticated types of cable services. On the other hand, population densities are higher, offering more potential subscribers per mile of cable laid. Economies of scale in construction and operation can also be achieved in metropolitan centers. New kinds of cable services will require new kinds and sources of funding, and new management concepts.

The impact of this new form of communications must be foreseen and provided for. Commercial activity, municipal services, education, law enforcement, health care delivery, and possibly even traffic control operations can all be supported in important ways by the improved communications that cable will provide. Appropriate planning must be initiated in time to make the organizational and procedural adjustments needed to take advantage of the new possibilities.

PROBLEMS FACING URBAN GOVERNMENTS

A number of problems and issues in cable communications are not primarily the responsibility of city governments and must be settled either through national legislation or through actions of federal regulatory bodies. For example, the coming of cable raises important questions about copyright payments that may be due to owners of broadcast programming picked up by cable systems and transmitted to subscribers. It is generally recognized that the problem can be settled only by Federal legislation, and at the time of writing of this report various proposals are being studied by the Senate Committee on Copyright, as part of a comprehensive revision of the Copyright Law of 1909.[1]

Another problem whose solution lies largely or wholly beyond the jurisdiction of cities is the interface and conflict between the cable industry and the broadcast industry. The cable regulations issued by the Federal Communications Commission on February 3, 1972,[2] deal with this problem in great detail and represent an attempt to open up a number of major markets to cable while providing the broadcasting industry with a measure of protection against the adverse economic impact that the introduction of cable to these markets might bring.

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[1] For a brief discussion of the copyright issue, see Sloan Commission on Cable Communications, On the Cable: The Television of Abundance, New York: McGraw Hill, 1971, pp. 51-58. For a more extended treatment see Leonard Ross, "The Copyright Question in CATV", Paper Prepared for the Sloan Commission on Cable Communications, April 1971. The cable copyright controversy is, in turn, one aspect of the growing issue of the relationship of traditional copyright laws and concepts to new electronic technologies. An important recent case is Williams & Wilkins Company vs. United States, U. S. Court of Claims No. 73-68, Report of Commissioner to the Court, February 16, 1972. For some innovative suggestions, see National Education Association, Memorandum to the Task Force on Computers, Information Systems, and New Technology of the Ad Hoc Committee on Copyright Law Revision, 7 pp., mimeographed, December 21, 1971.

[2] Code of Federal Regulations, Title 47, Chapter 1, Part 76 - Cable Television Service. See also FCC 72-108, Dockets Nos. 18397, 18397-A, 18373, 18416, 18892, and 18894. Reported in Federal Register, Vol. 37, No. 30, February 12, 1972.

There are, however, a large number of other areas in which the primary powers of decision lie with municipalities. A large share of the responsibility for assuring that cable's benefits will be realized in urban centers has fallen upon city, county and municipal government officials, who set the conditions for franchising cable systems in their jurisdictions. Mayors, city councilmen, local public utility commissioners, attorneys, and the staffs of the many agencies responsible for administering public services, have all devoted immense amounts of time to the problems of cable franchising. But they have often found that the crucial decisions require detailed technical information and knowledge that they do not possess and do not have the facilities and expertise to develop. A number of cities have turned to foundations and research firms for help.

In April, 1971, The John and Mary R. Markle Foundation commissioned this study of broadband cable systems for urban centers. The study attempts to deal in practical terms, and as fully as present knowledge will permit, with key questions confronting major cities in connection with the design, implementation, and use of urban cable systems. These questions, and the Sections of this report that deal with them, can be summarized as follows:

> What are the characteristics of an urban center, such as Washington, D. C., that have a bearing on the design and uses of a cable system that serves the city? (Appendix A)

- To what needs of urban centers can cable's potential uses be applied, and what kinds of programming and services should a cable system be able to deliver in urban centers, in order to respond to these needs? (Section III)
- What kind of a system should be built to deliver such programming and services? How should it be planned and installed? (Section IV)
- What components are available for building such a system and what new components need to be developed? (Appendix B)
- Who will be interested in receiving what kinds of programming and services, and how much will they be willing to pay for them? (Section V)
- How much will the system cost? What will be the expected return on the money that will be invested in the system? (Section VI)
- What impact could current uncertainties in the financing, design, operation and management of the system have on the system's economic viability? (Section VII)
- What types of demonstrations, cost-benefit analyses, and market surveys of new programming and services might help potential investors to resolve these uncertainties? (Section VIII)

Underlying these questions is the central issue in the building and operation of urban cable systems:

> Can a broadband urban communications system be designed that combines large amounts and varieties of new programming and services, moderate subscriber fees, participation by most households and offices, and system profitability?

The study was conducted by focusing on Washington, D. C., the nation's ninth largest TV market. It is expected that the quantitative data, mathematical models, system design and characteristics, and the financial analyses of costs, revenues and returns-on investment, developed for the analyses of the preliminary design of a Washington Cable System, will provide general guidance for the introduction of cable systems into most other urban centers.

PROGRAMMING AND SERVICES--THE KEY TO URBAN CABLE

This study has indicated that urban cable systems can combine profitability with:

- a broad range of new programming and services;
- widespread utilization of these programs and services by many elements of the city;
- flexibility to meet a wide range of needs of both the public and specialized users;
- moderate subscribers' fees for general programming and services;
- moderate charges for use of the system's transmission facilities for special services; and
- financial support from system revenues for the development of new programming and services.

The system design has evolved from comprehensive studies of the needs of the total community, available cable technology, the cost of producing various kinds of programs and services, the willingness of subscribers to pay for these programs and services, the revenues that might be derived from a variety of sources, and the economics of building and operating an urban cable system to deliver these programs and services under various conditions and assumptions. There has already been much discussion of these problems, but MITRE believes that this is the first study that explores the many important facets of alternative types and levels of service as well as their interrelationship with an overall urban cable system design.

An important conclusion of the study should be stated at the outset. The study affirms that the success of cable in Washington and other cities depends, to a high degree, on an adequate identification, development, demonstration, and market testing of a sufficient variety of new programming and services to insure its popularity with both the people and the many groups and organizations involved in the activities of the city.

A majority of cable systems operating today deliver a maximum of twelve channels of one-way service. New cable rules and regulations issued by FCC in February 1972 require cable systems in the top-100 markets to provide a minimum capacity of twenty channels. The rules also require cable systems in the top-100 markets to provide a two-way signal distribution system capability, although the provision of two-way terminals and services is not mandated at this time.

Most systems today, of whatever capacity, carry a selection of retransmitted local and distant broadcast signals as their principal offering to subscribers. Additional programming offered by some systems usually consists of a channel for local program origination, one or more "mechanical" channels providing a view of a clock, weather information, informational placards, and/or a view of a news or stock ticker.

This combination of services has proved highly attractive in small towns with inferior over-the-air reception. But its attractiveness is far less certain in urban centers, where over-the-air reception of a number of TV channels is often excellent, and where residents have relatively easy access to many other kinds of informational, educational, cultural, and recreational activities that compete with TV for the viewers' time and interest. At the same time, urban centers have many important communications needs that can not be met by either over-the-air broadcasting or limited forms of cable service, but that could be met by broadband cable systems with greater capacity, greater flexibility, and greater potential for delivering programming and services.

WHO WILL WANT WHAT?

To date cable systems have had some limited experience with community programming over local origination channels. But apart from that, the potential of cable to expand the uses of television in our society remains almost entirely untested and undeveloped. Equally undeveloped are many non-visual uses of broadband communications systems, including data communications for business and government, automatic meter reading, subscriber preference polling, fire and burglar alarm services for homes, shopping and banking by cable, and facsimile printout of books, newspapers, and reading material, both in offices and in the home.

To determine the market for various possible programs and services in Washington, MITRE commissioned the Howard University School of Business and Public Administration to conduct a consumer survey in the District of Columbia to measure both the general degree of public interest in various categories of programs and services and how much potential subscribers to the WCS would be willing to pay for them.

The results of this survey strongly confirm the supposition that a system offering only traditional cable services could not expect financial success in a city like Washington. Even at subscriber fees substantially lower than those charged by most cable companies, only a fourth of all households might be expected to subscribe. Not enough revenues would be generated under these conditions to make expensive urban systems financially viable.

On the other hand, the survey indicated that the system could become economically viable if it offered movies or coverage of certain sports events, or if some imaginative two-way services were offered. The Washington system has therefore been designed on the fundamental premise that its principal sales appeal and its economic success will not be based on the retransmission of broadcast TV signals alone It is perhaps the first urban cable system in the country to be designed on this premise.

MITRE believes that the real future of cable in urban areas lies with this type of comprehensive system, and that bold steps should be taken now to bring it into being. In the case of the Washington Cable System, these steps would include the creation and operation of nine cablecasting studios throughout the city, and strong financing for development, demonstration, and market testing of many new kinds of programming and services particularly during the first four years in which the system is being built.

Types of programming and services that survive the early demonstration and market testing phase would be incorporated into the system's standard offerings. When construction is completed at the end of the fifth year, the system would dedicate a portion of its revenues for financing new programming and services.

SYSTEM HIGHLIGHTS

The system designed by MITRE for Washington differs in many respects from the type of cable system that has thus far been franchised and built in most communities. Most of these differences stem from the differences in the types of services that the system is designed to deliver, as has just been discussed. Several other differences should be brought to the reader's attention before the details of the system are discussed.

(1) Two Nets Instead of One. The Washington Cable System would actually consist of two overlapping systems, called the public or "telecasting" net and the point-to-point nets. The telecasting net would be the one to which individual households would subscribe, just

as they would subscribe to any cable system. It would be built to handle evolutionary growth in the types and volumes of services that would be provided without the necessity of changing or rebuilding the distribution net.

The telecasting net would be a dual-cable facility, with one cable being activated initially for the delivery of One-Way Services. After several years the second cable would be activated for the delivery of two-way Subscriber Response Services. These would involve certain types of interaction between subscribers and the source of the programming. A third level of capability, Electronic Information Handling Services, which would give subscribers direct individual access to output from high-capacity computers, would be added as new types of terminals become available and as program materials for this mode of transmission are developed and their usefulness and marketability are tested. Types of services that could be delivered in each category are listed in Table II-2;summary descriptions of the system and the services it would offer appear in Section II; and detailed descriptions are given in the balance of the Report.

In addition to the telecasting net there would be four point-to-point nets, one each for interconnecting Federal offices, municipal offices, business and commercial users, and educational institutions. These nets would provide approximately equal channel capacity in both directions, since transmissions might originate from any point in a net to any other. The telecasting nets and the point-to-point nets would be interconnected, so that material originating anywhere on the point-to-point net could be transmitted over part or all of the telecasting net if and when desired, and vice versa.

MITRE recommends that every major city consider the usefulness and economics of such overlapping cable nets, along the lines described in this Report. They give the system the capacity and flexibility that will be needed to meet future requirements for broadband communications in urban centers, and a stronger long-term financial base.

(2) Large Amounts of Service for Moderate Fees. The Washington system would be a dual-cable facility. Subscribers would have the option of subscribing to one or both cables. Subscription to the first cable only would cost $3.50 per month. For this fee subscribers would receive up to thirty channels of one-way services, for substantially less than the $5-to-$6 per month now charged by cable systems offering no more than 12 channels of service.

For $6.50--just slightly more than the average fee being charged by cable systems today--the subscriber would receive additional special one-way programming and two-way subscriber-response programming and services.

For an additional fee of between $15.50 and $8.50 per month, no more than many or most families pay for telephone service, the subscriber could obtain a variety of sophisticated services, referred to in this report as Electronic Information-Handling Services.

It should be noted that these moderate fees stem from a style of fiscal management that seeks and expects profitable operation but does not seek either the highest possible profit or the earliest possible returns on capital investment. The Howard University market survey conducted in connection with this study indicates that a sensitive relationship exists between the level of subscriber's fees and the resulting number of subscribers. The study found that a cable system could be operated more profitably by charging higher fees, but such a policy would lower the percentage of households that would subscribe. These relationships among subscriber's fees, penetration, and return on investment, obviously pose important policy decisions for municipal governments.

Other characteristics that would be part of the Washington Cable System design would include: the creation and operation of neighborhood cablecasting studios; reinvestment of system profits in the demonstration and testing of new programming and services, some of which might prove to be socially valuable although they would not generate profits; investment of large sums from revenues in programming, and assistance to communities and citizen groups in developing programming and services that will be responsive to their needs; and investment in two-way terminals, to be provided without charge to all subscribers wishing to have these services when they are provided by the system.

It would of course be possible to provide far less financial support for these purposes, and to apply the income thus freed to debt retirement and/or distribution of profits. The issue again becomes one of the goals that the city wishes to achieve through the franchising and introduction of cable communications.

PROBLEMS AND ISSUES OF OWNERSHIP

This report describes what is fundamentally a single system for the entire city. It is designed to reflect such advantages of unified planning as operational economy and technological efficiency. The basic plan for the system envisages that it would be operated under a single management structure, with community needs being met through the use of nine separate cablecasting hubs with studio facilities at each hub, and leased channels for public access.

Additional features of a city-wide system under unified management include:

- Simplified coordination of city-wide cablecasting programming and schedules from a master headend.
- Sufficient system size to achieve economies of scale in procurement, and to generate substantial funds for the purchase and production of programming.
- Avoidance of complex problems of interconnection and coordination of channel allocations, maintenance responsibilities for both the systems and the interconnecting links, and achievement of uniform technical specifications and levels of performance.

. Assurance of an equitable timetable for cable service to all parts of the city with uniform levels of fees and service. If the city is divided, some areas will be more costly to wire than others. If separate franchises are granted in different areas, these less financially attractive areas may never attract franchise bidders. If and when they are franchised, they may be forced to charge higher subscriber fees and to offer less service to their subscribers than cable systems in more financially viable districts of the city.

. Relative ease of construction and operation of a point-to-point net covering facilities in all areas of the city.

It should be noted that in Washington and other major cities, important pressures exist for dividing the city into several geographical areas and granting separate franchises. A number of reasons for doing this have been advanced, including the following:

. Each system would require a smaller total capital investment than would be required for a city-wide system, and a larger number of parties would therefore be in a financial position to compete for franchises. Thus cable could become an important new locally-owned business in the inner city, providing revenues, job opportunities, and training in marketable skills for low-income areas and minority groups.[3]

. Subdivision of the city and granting of franchises to locally based firms could result in cable systems that are more responsive to the needs of the communities in which they are built. By contrast, if the entire city is franchised to a private operator, the high cost of building a city-wide system in major centers would limit the viable bidders to a few of the largest multi-system operators. The management of such firms is often located in cities far distant from the city in which the system is to be built; the management must concern itself with the economic fortunes of the entire group of systems that it owns in widely-dispersed cities; and such management might therefore be remote and unresponsive to the individual problems of the city, and even less responsive to the individual needs of neighborhoods and communities within the city.

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[3] This view is strongly advocated by many black leaders. See, for example, Charles Tate, editor, Cable Television in the Cities: Community Control, Public Access, and Minority Ownership. Washington, D. C.: The Urban Institute, 1971, pp. 2, 3, 13, 14, 16-18.

- Within a given city, separate franchises could be granted both to profit-making and non-profit management groups, and their performance could be compared.[4]

One problem that cities should consider if they grant separate franchises is the fate of the point-to-point net, which MITRE believes to be important for the delivery of a full range of broadband services in cities. The problem is complicated by the fact that the point-to-point net would provide many city-wide services that might not be immediately profitable in and of themselves. Point-to-point nets might therefore not be financially attractive entities to franchise separately.

One solution might be to require each franchisee, in separate areas of the city, to build those portions of the point-to-point nets that would cover various facilities within his franchise area, and to require him to connect these portions with such portions of the nets in other franchised areas. This would mean the point-to-point nets would be under fragmented management, and the city would have to consider arrangements for preparation of very detailed system specifications and control over certain vital operating decisions regarding the fees, management, maintenance and use of the networks.

Another alternative might be for the city to require that the point-to-point nets be operated as a separately franchised system, contracting for installation and use of portions of the point-to-point nets to be constructed by the telecasting net franchisees. The point-to-point nets would then be operated as specialized common carriers to obviate some of the problems of operator control over the content of the material transmitted by the various users.

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[4] This approach is advocated by the Ford Foundation. See FCC Docket 18892, Comments of the Ford Foundation, December 7, 1970, p. 11.

No matter what method is used to create the cable system, the cable for the point-to-point nets should be laid at the same time that the cable is laid for the telecasting nets in order to minimize installation costs.

Among other considerations involved in separate franchising are the following:

- If separate franchises are granted, detailed requirements for interconnection capability should be imposed on each franchisee.
- One system might be designated to build a headend capable of signal importation, which could then serve all the systems as they are implemented, thereby spreading these costs among all the systems.
- MITRE's analyses indicate that underground construction is three to four times as costly as stringing the equivalent amount of cable above the ground. Because of existing regulations, some sections of a city will normally require substantial amounts of underground construction. This will almost certainly be reflected in higher subscriber fees if such areas are franchised separately. If a number of franchises are issued, City Council should carefully weigh this factor. The geographical coverage of each franchise area should be designed to produce uniform subscriber fees throughout the city.
- In any case, there is no doubt that the sections of each system that use aerial cable will necessarily subsidize the sections that require underground construction, if uniform subscriber fees are charged throughout the city.

In this report, the construction of a city-wide system in Washington has been divided into five stages, each stage involving a different geographical sector. Two of these sectors would involve heavier underground construction than the rest. The costs of building each of these sectors have been broken out separately (see Section VI). Such cost breakouts could be useful if separate franchising is considered.

Another alternative that a city may wish to consider is the granting of a single, city-wide franchise to a non-profit development corporation, or to a quasi-public body whose corporate structure, embodying both profit-making and non-profit interests, could resemble that of COMSAT. Such a franchisee could pursue management goals paralleling those of the city. Its management would be locally-based. Large amounts of responsibility for operation and programming of various sectors of the system could be delegated to both community-based profit-making firms and non-profit civic groups, while the franchise continues to provide a focus for decision-making, operation, and programming for those functions of the system that are inherently city-wide. General oversight could be provided by a city agency specifically concerned with the formulation of goals and policies in the field of telecommunications. An arrangement of this type could give wide latitude for the growth of both profit-making and non-profit uses of cable communications in urban centers.

The ownership question involves a great many issues that are neither technical nor strictly economic. These issues have been considered in the system design presented in this report, but are not appropriate to address in the body of the report. Appendix C, "Problems of Cable System Ownership", presents a more complete discussion of the issues involved, illustrative examples of how they are being addressed to specific situations, and alternative ownership strategies that should be considered by cities. Appendix C also identifies appropriate references for readers concerned with specific issues.

SECTION II

SUMMARY OF THE WASHINGTON CABLE SYSTEM

BACKGROUND

The city of Washington, D. C. has been selected as a candidate site to provide a point of focus for an examination of the social utility, technical feasibility and economic viability of urban cable systems. In the initial stages of the program, the character and nature of the District were studied, using available demographic, social and economic data. These studies served to provide the early indications of critical needs. Later, a series of interviews were held with various elements of the community to determine additional requirements. Finally, a projected list of future requirements was developed. These requirements and needs are addressed in a specific set of telecommunications programs and services developed in this program.

This section of the report is intended to provide a comprehensive summary of the in-depth analysis and design material presented in the subsequent sections. The summary material has been sub-divided into the following topics:

- Characteristics of Washington, D. C.
- Programming & Services
- System Design
- Technical Alternatives
- Demand Analyses
- Financial Analyses
- Sensitivity Analyses
- Demonstrations

CHARACTERISTICS OF WASHINGTON, D. C. (APPENDIX A)

The District of Columbia has many unique characteristics. As the capital and home of the Federal government of the nation, it is a leading national and international center. Its numerous Federal buildings, universities, museum and galleries as well as the new Kennedy Center for the Performing Arts, make it a center for both culture and tourism. Under the existing political structure, municipal authority for the city and its 700,000 residents is divided among the Executive Branch, Congress, Federal Agencies, Mayor and the City Council. Washington as the central city of the ninth largest--and most rapidly growing-- metropolitan area in the country, experiences many of the problems common to most urban areas such as violent crime, inadequate housing, declining educational achievement, and lack of health care.

In an effort to improve municipal planning for dealing with these problems, Mayor Walter Washington has established nine Service Areas for the administration of various public services. Under this system, all municipal and Federal programs are coordinated through the local Service Area administrator. This system produces a series of demographic, social and economic indicators which are routinely collected and readily available for monitoring activities. Our analysis of these indicators reveals unique characteristics within the individual areas and accordingly, MITRE has designed a system using the Service Areas as basic building blocks for the Washington Cable System (WCS).

PROGRAMMING AND SERVICES (Section III)

The success of the system will depend, to a high degree, on an adequate identification, development, demonstration and market testing of a sufficient variety of new programming and services to insure financial viability and acceptance within the community. At present Washington enjoys excellent over-the-air reception from three network TV outlets, two independent stations and an educational station. In addition, many residents are able to receive additional services from five nearby Baltimore TV facilities. Our studies indicate that many of the informational needs within the District are not being adequately met by existing over-the-air services. The broadband cable system with its greater capacity, flexibility and potential permit it to provide a wide variety of programs and services to address specific needs that have been uncovered in the course of this program. Some of the specific user groups addressed follow:

Inner City Residents. The largest clientele for government services is located in the inner city. Their needs are difficult to meet through existing media. Although low-income groups and minority groups rely predominantly on over-the-air television as a source of public service information as well as entertainment, the high cost of commercial broadcast time makes television an impractical medium for extended contact between governmental service agencies and citizens of the inner city.

By contrast, a high-capacity cable system, with numerous channels and low transmission cost, can make cable television available for such communication. Programs ranging from brief "spots" to regularly scheduled presentations and series, can deal with such matters as: employment, job training, information on health care, child care, and health services; information on how to secure other services and benefits; and programs to assist consumers. In the near future it will be possible to personalize many of these programs and services through the use of two-way (interactive) communications which will put individuals in direct contact with the source of the programming.

Education. Educational needs are an increasing burden on both the municipal budget and the budgets of individual citizens. Washington's public school budget has steadily increased during the past decade while reading and math scores have declined. Institutions of higher education are at the breaking point in maintaining even the present levels of quality in the face of rising costs. There is general agreement that major changes will have to be made during the 1970's in how education is delivered, from the pre-school to the university level. Creative uses of instructional and educational programming are likely to emerge as one of the most important and central contributions that cable systems can make to urban life. This report includes plans for several new kinds of educational services, managed by a consortium of the city's universities, designed to serve a broader segment of the public.

Health Care. Health care is another field in which basic changes will have to be made in our delivery systems. Such changes will involve, for example, the introduction of methods for electronic exchange of patient records, remote diagnostic analyses, and both the updating and the continuation of the education of medical personnel, all via cable. Two-way video hookups which enable specialists in central hospitals to see, and in some instances diagnose and prescribe treatment for, patients in outlying clinics, are already being demonstrated. Municipally-sponsored programs on health and child care will extend the reach of preventive medicine into the inner city. Programmed information on health problems can be summoned from computers to the home screen by subscribers with data-entry terminals in their homes. The proposed Washington system includes plans to demonstrate all of these improved health care capabilities.

Community Communications. All cities, including Washington, suffer from loss of community, disruption of life patterns, and social alienation. This malaise is one causative factor in the more tangible problems of the city. Local and community dialog, made possible by cable, offers one tool that might help to at least partially rebuild a sense of neighborhood, community, and identity. The MITRE system plan gives high priority to this need by creating local studios throughout the city, by recommending strong financial support for programming, and by providing many channels for public access, some free and some on lease at moderate fees.

Public Safety. The police, courts and prisons of all our metropolitan areas must find better ways to handle the increasing demands on their resources. Examples of assistance that cable communications can provide to law enforcement functions include transmission of records including fingerprints, presentation of evidence and expert testimony, providing of a medium for in-service training of police, and transmission of educational materials to prison populations. Traffic can be monitored and controlled through the use of cable-connected traffic lights and computers. Burglar and fire alarms in homes and commercial establishments can be transmitted automatically to central monitoring stations, police cars, fire stations, and even to patrolmen in the emergency area, through a cable and mobile radio communications network, providing efficiencies in response times and equipment allocations. Video monitoring of fires and civil disturbances can improve evaluation and central management capabilities.

Cultural and Entertainment Programming. Large amounts of cultural and entertainment material never find their way onto broadcast television because of pressure on commercial TV outlets to offer only programming that will attract the largest possible audiences. Some material--for example, the Metropolitan Opera, or a chess tournament--would have great appeal to specialized audiences. Other material, generated by individuals or groups within the city, is often of high quality, but has little chance of being seen on commercial TV. Cable can open up whole new avenues for television to cater to diversified tastes and to give artistic talent a visual outlet for expression.

Table II-1 illustrates ways that cable telecommunications would address some of the needs and opportunities of Washington, D. C., over the next ten years.

The Washington system will provide five separate service options which are designated as follows:

- One Way
- Subscriber Response
- Electronic Information-Handling Services
- Special
- Point-to-Point

Table II-2 summarizes the services, capital costs per subscriber and system components for the five service options. The following paragraphs summarize the services provided by each of the options.

One Way. To receive this kind of programming, the subscriber will need only his home TV set and a small set-top converter so that he could view more than 12 channels. The set-top converter will be provided, free of charge, to a subscriber who elects to pay a monthly fee for one-way programming services. In addition to the more conventional cable services outlined in Table II-2, a number of special programs and services can be made available on subscription or "pay TV" channels, with persons, who wish to see them, paying additional fees. Additional equipment will be required and paid for by these additional fees. Subscribers will thus be able to purchase programming and services for which they had an individual interest or need, and which could not otherwise be financially supported. Material shown on subscription channels could include programming that will appeal to individualized cultural, artistic, entertainment, and hobby

TABLE II-1
ILLUSTRATIVE OVERVIEW RELATING TELECOMMUNICATION
SERVICES TO THE CITY

FUNCTIONAL AREAS	TELECOMMUNICATION SERVICE POSSIBILITIES
Entertainment and Culture	. High quality color reception of local and imported signals . Community access to the telecasting net
Political	. Local interest issues and options unique to Service Area . Opinion polling . Public monitoring of political procedures
Education	. Educational TV programs from and between a consortium of universities and D. C. public schools . Computer-aided instruction available throughout city (academic, vocational, functional)
Law Enforcement	. Expanded police station and call-box communications capability for training, video data transfer (mug shots, fingerprints, etc.) and TV surveillance capabilities
Medical Care	. Interconnected diagnostic and hospital centers . Distribution of health care information
Unemployment	. Job opportunity programs . Daily classified ads via TV (sorted by topic)
Traffic	. Dynamic traffic control . Automatic vehicle location monitoring
Utilities Management	. Power, gas and water system monitoring and control with incentive (pricing) oriented consumption management

TABLE II-2
POTENTIAL SERVICES

ONE-WAY SERVICES	Capital Costs:
. Local Signals . Continuous news, time, weather, FM radio . Imported signals . Movies and sports . Local programming . Educational access . Municipal government access . Public information services* . Instructional programming . Health services . Special interest programming . Communications for Pay TV, professional channels, and private modes**	~$150 per subscriber, not including cost of home TV set System components: . Conventional headend antennas and signal processors . One-way dual-cable distribution system . Set-top converter for use with dual cable in each home
SUBSCRIBER-RESPONSE SERVICES	Incremental capital costs:
. Interactive entertainment . Interactive education . Preference polling . Catalogue shopping . Alarm communications . Communications for utility and maintenance services	~$150 per subscriber Additional system components: . Minimal computer at headend . Return channels in cable distribution system . Keyboard, coupler and address decoder in each home

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* Public information services, such as notices of community events, classified ads, etc., could be provided under One-Way Services, using mechanical originations, or under Electronic Information-Handling Services, using a frame-stopping terminal.

** Communications for pay TV, professional channels and private modes could be provided by one-way leased channels, with the addition of either a scrambler-descrambler system or a non-standard channel (see Appendix B). They could also be provided under Subscriber-Response Services using an address coder-decoder system.

TABLE II-2 (Concluded)

ELECTRONIC INFORMATION-HANDLING SERVICES . Computer-aided instructions . Interactive entertainment . Social services . Video library . Individualized shopping and reservations . Banking and credit . Public information services . Pay TV, professional channels, and private modes	Incremental capital costs: ~$400 per subscriber Additional system components: . High-capacity computer at headend . Refresh unit (i.e., solid-state memory, storage tube, video disc, a video tape recorder) in each home
SPECIAL SERVICES . Traffic control . Mobile radio communications and automatic vehicle monitoring . General purpose digital communications . Local distribution for special common-carrier services	Incremental capital costs: Vary by application Additional system components: Vary by application
POINT-TO-POINT SERVICES . Municipal government . Federal government . Colleges and universities . Business and commerce	Incremental capital costs: Vary by application Additional system components: Vary by application

audiences, as well as programming for various professional groups such as doctors, that would provide information and material to update them in their professions.

Subscriber Response. This is a form of two-way communications that enables the subscriber to transmit signals back to the source of the programming. A subscriber response terminal is required, with a set of buttons or a small keyboard for transmitting. The WCS would provide a subscriber response terminal, free of charge, to every subscriber who elects to obtain this type of programming and service.

Two-way communications are one of cable's most intriguing frontiers. The social, cultural, educational, and commercial applications of this new form of communications are not yet known. Many of the demonstrations and tests proposed by MITRE in connection with the development of urban cable systems, would be devoted to building a body of knowledge and experience in the use of two-way cable communications.

Electronic Information-Handling. This is more sophisticated than the Subscriber Response since this option provides the subscriber with extensive access to computers for the retrieval of large amounts of informational, educational, and cultural material. It would require a more versatile and more costly home terminal than is required for subscriber response.

Electronic information-handling, giving subscribers direct access to the memory bank and computation capability of computers and making use of frame-stopping technology, can ultimately make immense amounts of educational, informational, and cultural materials available in the home. For subscribers wishing to obtain electronic information-handling services, and willing to pay a subscriber fee, the cable system would provide a frame-stopping terminal free of charge.

A number of the services available through electronic information-handling, particularly such matters as mail delivery and banking information, involve important considerations of privacy. The same is true of access to professional channels, in which the categories of viewers should perhaps in some cases be restricted. High degrees of privacy--sufficient, for example, to protect the delivery of mail--can be achieved on cable systems, using technology now in existence. Available methods of providing privacy include the use of scrambler-descrambler systems, channel shifting systems, address coder-decoder systems and switching systems.

Special. A variety of special services would be provided on leased channels that will not be transmitted into homes of the regular subscribers. Special subsystems would be provided for these services and separate fees would be paid by the users of these subsystems. Such special services would include the following:

- Communications for municipal traffic control subsystems.
- Communications for interconnection of central processing units and distributed transceivers that would be used for cellular mobile radio communications and automatic vehicle monitoring.

- General purpose digital communications between computers and data processing equipment located throughout the city.
- Local distribution of inter-city communications provided by special common-carriers.

Point-to-Point This service provides dedicated communications channels for large volume users. This service will operate independent of the earlier mentioned service. It is anticipated that four major user groups will be involved which include Federal government, Municipal government, commercial and institutional users and higher education institutions. The system will include four separate and independent nets as outlined above. The point-to-point service would facilitate the improvement of present services, and make possible the delivery of new ones, in such areas as law enforcement, education, fire protection, traffic control, health services and health care, social and community services, and improved government administration. They would become highways of data transmission, available at lower cost than present data transmission modes. Two-way links among hospitals, clinics, and health care facilities, making possible the sharing of records, medical information, and "telediagnosis" by two-way video, would be carried on the point-to-point nets. Training, surveillance, and records transmission among police facilities, and the transmission of expert testimony, records, and evidence for use in court, would be among the services available for improving law enforcement.

In education, schools would be able to share teachers, films, video cassettes, and other visual material, with each other, with students who cannot be present in the classroom, and with the community at large. As part of the process of designing the Washington Cable System (WCS) MITRE has developed, with Washington's consortium of universities, plans and cable facilities for the delivery of college courses to the public and the exchange of courses between members of the consortium which will both expand capabilities and realize cost savings. Similar, but less specific arrangements have been discussed in joint meetings with representatives of the area's 10 community colleges, and the groundwork has been laid for more detailed agreements after franchise actions are initiated.

SYSTEM DESIGN

The WCS system consists of nine separate subsystems, each associated with one of the Service Areas (see Figure II-1). This approach provides for greater flexibility of operations and provides high signal quality for all subscribers. Each subsystem has a studio suitable for modest production work of local neighborhood and community interest programs. All subsystems will be interconnected by a "transport" system of either trunk-line cable or a microwave air link. To supplement the local studies, three mobile studios will be provided for use throughout the system. These units will be self-contained and will include: color cameras, tape recorders, various signal processing equipment and generator power.

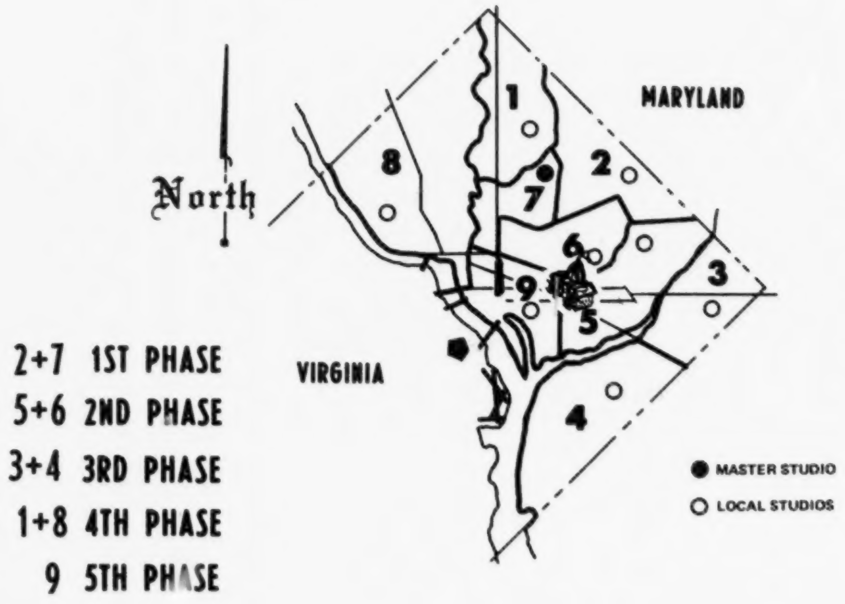

FIGURE II-1
WASHINGTON, D. C. SERVICE AREAS AND MASTER AND LOCAL STUDIO LOCATIONS

The overall WCS system consists of two, independent overlapping nets as illustrated in Figure II-2. The Telecasting net is a dual-cable net, covering the 1,076 city street miles. This net provides one-way, subscriber response, electronic-information and special services throughout the city. The Point-to-Point net consists of four sub-nets covering a total of 148 strand miles. The sub-nets provide point-to-point services to higher education, business, Municipal and Federal facilities.

The Telecasting Net

The telecasting network consists of a number of hub-like distribution systems with the subheadends for each Service Area constituting the hubs. The programming material and other information pass from the hubs downstream to the subscriber. The telecasting net consists of dual cable plant, each cable providing up to 30 forward and four reverse channels. Set-top converters will be required to access the total channel capability. In addition, these converters provide protection from high-signal-strength local stations. In order to ensure that the system will secure the required subscriber penetration, it will be necessary to provide improved quality of off-the-air signals. MITRE estimates that a TASO "fine" picture will be required for at least 90% of the subscribers to provide an appreciable improvement over off-the-air pickup. Thus, the WCS will require technical specifications that are more rigid than those currently being proposed by the FCC.

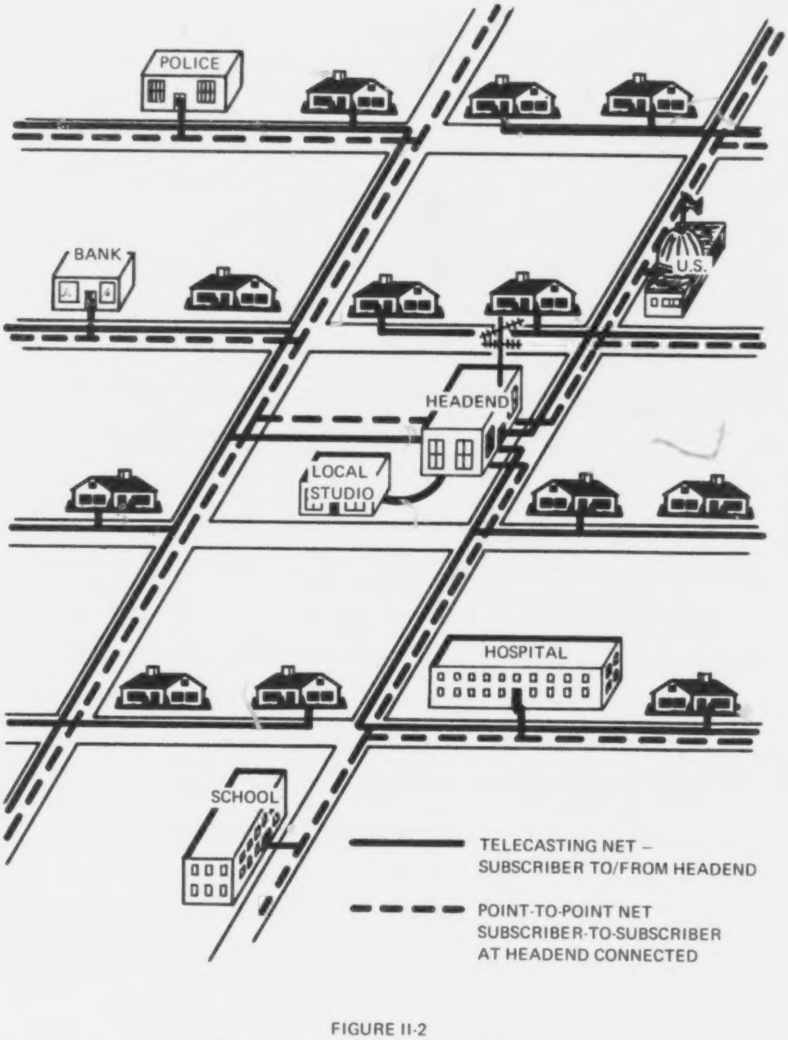
POLICE
BANK
U.S.
HEADEND
LOCAL STUDIO
HOSPITAL
SCHOOL
TELECASTING NET – SUBSCRIBER TO/FROM HEADEND
POINT-TO-POINT NET SUBSCRIBER-TO-SUBSCRIBER AT HEADEND CONNECTED

FIGURE II-2
TELECASTING AND POINT-TO-POINT NETS

Point-to-Point Net

The Point-to-Point network will be demand-oriented in that services will not always be prescheduled, and the users may want to send large volumes of data at particular times but not necessarily periodically. This generates the requirement for connecting these users rapidly and in a flexible way. In order to provide the necessary system flexibility, an equal number of forward and reverse channels (14-6 MHz channels each way) will be provided on the point-to-point nets. Switching capabilities provided at the headend and subheadends will be used to satisfy the varying demands of the users.

The four point-to-point nets that would be available would consist of the following:

The Federal Net. This will be a dual-cable facility providing 30 channels in each direction, linking up the Capitol Building and over 50 other major Federal buildings and agencies. It will be principally devoted to data transmission, and will include a switching facility for subdividing and grouping the various users.

The Municipal Net. This net will serve all major municipal offices and facilities, including police and fire departments, hospitals, public schools, and agencies providing municipal services. Converters within the system will prevent each user from having access to any channel other than his own.

The Institutional Net. This will serve commercial and institutional users, including banks, department stores, credit associations, and utility companies. We estimate that there will be hundreds of users of this net. It will have the same converter feature as the Municipal Net.

The Higher Education Net. American University, Catholic University, Federal City College, Georgetown University, George Washington University, Howard University, and many other institutions of higher education in Washington will be interconnected in this net.

The second, third, and fourth nets will each be single-cable systems, with fourteen channels for transmission in each direction.

Implementation of the System

The system will be built over a five-year period, and the services offered by the system will be expanded in stages during the building period, as indicated in Figures II-3 and II-4. At first the system will offer 30 channels of one-way service, on one of the two cables. Here four channels of the second cable will be used for experiments, demonstrations, and market surveys of two-way uses, with two-way terminals being provided to selected households participating in the tests. One hundred such terminals will be distributed in the first year, 1,000 more in the second year, and 5,000 more in the third year, making a total of 6,100 two-way demonstration terminals.

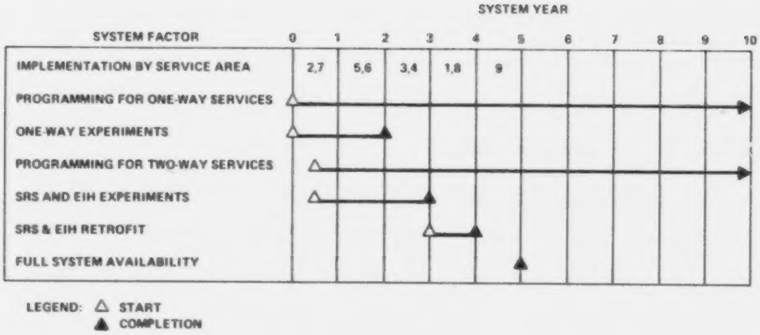

FIGURE II-3
MILESTONE CHART FOR WCS SERVICES

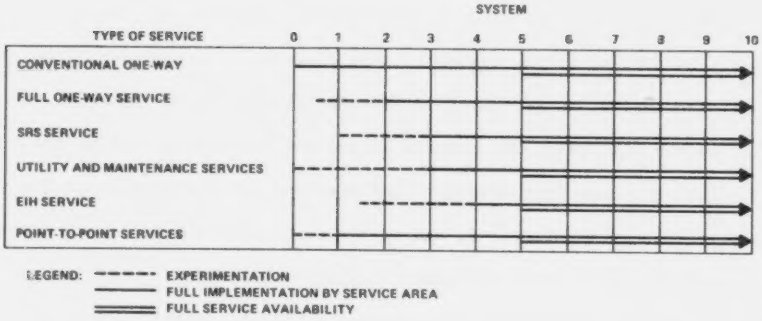

FIGURE II-4
IMPLEMENTATION PLAN FOR WCS SYSTEM

By the fourth year, a series of decisions will have been made on the kind of two-way services that the system should offer. Both cables would be energized throughout the system, and the full capacity of 60 downstream channels to the subscribers, plus four upstream channels for two-way communications, will then be available. Recommended channel allocations are shown in Table II-3.

TECHNICAL ALTERNATIVES (Appendix B)

To provide the capabilities for one-way, subscriber-response, electronic information-handling, special, and point-to-point services, an extensive survey was conducted of equipment availability and possible hardware configurations. Technical and cost data were obtained from MITRE's computer interactive-home-terminal demonstration system in Reston, Virginia, as well as from numerous hardware manufacturers. These data were used as inputs in the system design summarized in Section IV.

The types of home-terminal equipment that would be used with one-way services, subscriber-response services and electronic information-handling services are shown in Figure II-5. The distinguishing piece of home terminal hardware required for the one-way services is a set-top converter. For the subscriber-response services, a small keyboard, coupler and address decoder is added. For the electronic information-handling services, video refresh device for the frame-stopper function is added. The frame-stopper holds, or stops the individual television images that are transmitted

TABLE II-3
RECOMMENDED CHANNEL ALLOCATIONS FOR WCS TELECASTING SYSTEM

CABLE 1 (Downstream)	NUMBER
1. Local Signals	7
2. Imported Cable Signals	3
3. Imported Off-The-Air Signals	2
4. Continuous News, Time, Weather	1
5. Local Programming	
a. Public Access	2
b. Local Origination	1
6. Special Interest Programming, Movies, and Sports	1
7. Dedicated Channels for Lease (1-way)	2
8. Public Information Channel	
a. T.V. Guide	1
b. Community Events, Ads	1
c. Health Services	1
9. Instructional Channels (1-way) for D.C. Schools and Universities	4
10. Municipal Government Access Channel	1
11. Pay TV[3]	1
12. Unassigned[1]	2
TOTAL	30[2]

CABLE 2 (Downstream)	
1. Imported Cable Signal	1
2. Preference Polling and Shopping (2-way SR)	1
3. Alarm, Utility and Maintenance	1
4. Professional Channel	1
5. Social Services (2-way EIH)	2
6. Interactive Educational Channel (2-way SR)	1
7. Interactive Entertainment Channel (2-way SR and EIH)	1
8. Individualized Shopping and Reservations	1
9. Banking and Credit	1
10. Computer-Aided Instruction	12
11. Special Services Channels	3
12. Pay TV[3]	1
13. Unassigned[1]	4
TOTAL	30[2]

CABLE 2 (Upstream)	
1. Data entry/request channels from terminal to headend or subheadends and video return channels (one return video channel can provide for many narrowband return channels)	4
TOTAL	4

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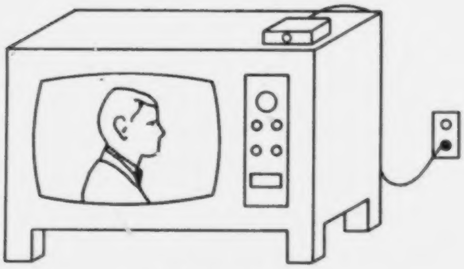
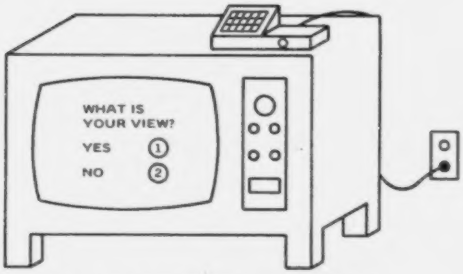
[1] The two channels of each cable in the Aircraft navigation band would be held in reserve until field measurements to check radiation could be made.

[2] Each cable can provide for 30 downstream channels plus the 88 MHz to 108 MHz FM band.

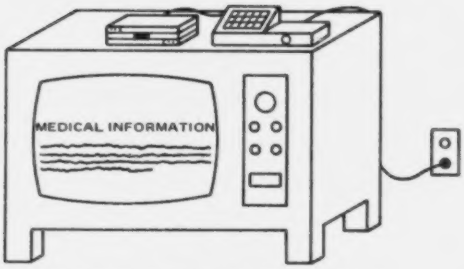
[3] See Footnote #2 - Table IV-5



ONE-WAY SERVICE



SUBSCRIBER-RESPONSE SERVICE



ELECTRONIC-INFORMATION HANDLING

FIGURE II-5
THREE TYPES OF SUBSCRIBER TERMINALS

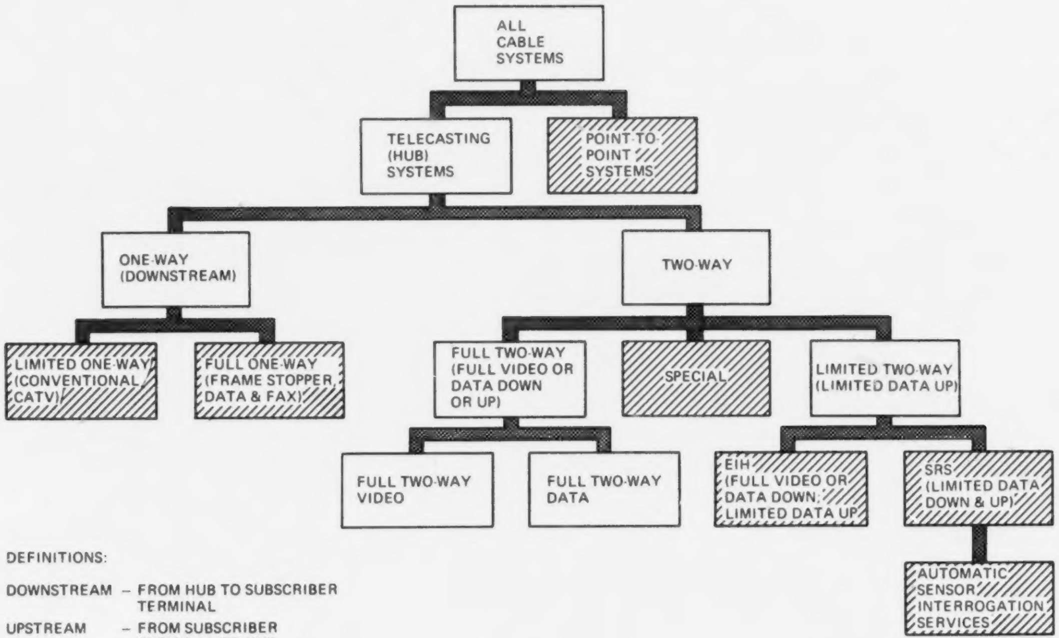
every 1/60th of a second in ordinary television; the displayed image which appears as a stop action picture on the screen can be held for any desired period of viewing.

The overall hierarchy of cable systems is shown in Figure II-6. Systems are classed as either telecasting systems or point-to-point systems. MITRE has investigaed the technical alternatives for all of the types shown, to some degree. However, the analyses in this report have concentrated on the boxes shown with cross-hatching. Highlights of this analysis are given below.

Headends

It is recommended that the master headend for the system, as well as eight subheadends, will each have the capability to receive local and imported off-the-air signals, and locally generated cablecasting signals. Each will have a complement of equipments to control and change frequencies, amplify and filter the signals and insert them into the cable distribution system. The headends will also have mechanical origination equipment to provide weather, news, time, stock market reports, etc., as well as computers that store information and select, address and switch frames that are then transmitted to terminals throughout the telecasting system.

The interconnection of headends in the system will be accomplished by a "transport' system consisting of cable or microwave links. Analyses have indicated that a cable transport system will probably


ALL CABLE SYSTEMS
TELECASTING (HUB) SYSTEMS
POINT-TO-POINT SYSTEMS
ONE-WAY (DOWNSTREAM)
TWO-WAY
LIMITED ONE-WAY (CONVENTIONAL CATV)
FULL ONE-WAY (FRAME STOPPER, DATA & FAX)
FULL TWO-WAY (FULL VIDEO OR DATA DOWN OR UP)
SPECIAL
LIMITED TWO-WAY (LIMITED DATA UP)
FULL TWO-WAY VIDEO
FULL TWO-WAY DATA
EIH (FULL VIDEO OR DATA DOWN, LIMITED DATA UP)
SRS (LIMITED DATA DOWN & UP)
AUTOMATIC SENSOR INTERROGATION SERVICES

DEFINITIONS:

DOWNSTREAM – FROM HUB TO SUBSCRIBER TERMINAL
UPSTREAM – FROM SUBSCRIBER TERMINAL TO HUB

FIGURE II-6
HIERARCHY OF CABLE TELEVISION SYSTEMS

have more reliability and greater growth potential than a microwave transport system. However, a microwave transport system may prove to be more flexible than a cable transport system and, because of low signal attenuation on its links, may eliminate the need for local-signal receiving-antennas at the subheadends. Instead, these signals could be distributed from the master headend to each subheadend. Further tests are required to determine the relative costs and effectiveness of these alternatives.

Distribution

The distribution of up to thirty channels on a single coaxial cable has been suggested by the major equipment manufacturers. A dual-cable design with each cable carrying up to 30 channels is described in detail in Section IV. This design is suggested for use in the WCS, with several caveats.

Early tests of two-way distribution by cable operators and equipment manufacturers indicate that significant technical problems still exist with the diplexor filters that separate the two directions of transmission. The principle problem is delay distortion which causes the depth and hue to be incorrectly reproduced at the color television receiver. Other problems result from coherent noise interferences picked up at the cable connection to the home and noise introduced into the return path through the use of two-way amplifiers. These latter two problems have several remedies, some of which are currently being tested.

Since it is expected that there will be field testing of fully loaded thirty-channel cable systems before the WCS is installed, these tests can be used to determine the final design of the system and the actual capacity that will be used in the WCS cables.

Terminals

Most of the troubles that have plagued users of set-top converters during the last few years have been brought under control through the use of IF stages that operate in the UHF band rather than in the sub-VHF band. Set-top converters for use with 30 channel one-way systems will cost about $27 apiece.

Home terminals that would be used for subscriber response services are now being tested in El Segundo, California, Overland Park, Kansas, Orlando, Florida, Reston, Virginia, as well as in a few other places. The additional hardware needed for subscriber-response terminals is expected to cost from $50 to $250 depending upon the quantities produced and the features provided. For instance, the more expensive types would provide a strip-printer as well as a keyboard and coupler/decoder unit.

The ability to freeze or stop television pictures has been successfully demonstrated in Reston, Virginia. The hardware to perform this video storage function could be provided by either a video tape recorder, an image storage tube, a video disc or solid state memory. The hardware needed for a single-frame alphanumeric frame stopper can be expected to cost under $200 in two to four years. Video tape recorders or video discs, used as frame stoppers, may cost about $500 apiece, and an image storage tube, with associated electronics, is likely to cost in the range of $200 to $500.

Premium TV and Private Modes

Premium TV programs, such as first-run movies, special national sports events, etc., will generally be cablecast on exclusive channels to large audiences. Special programs for doctors, lawyers or other professional groups could also be provided in this mode.

Premium TV modes of operation can be implemented on one-way systems by one or a combination of the following methods:

- Sending the signal on a channel outside of the normal television band.
- Sending a scrambled signal on an unused regular channel.
- Using some sort of switched or address-gated interconnection.

On the other hand, it is expected that private cable services such as mail delivery, bank account information, credit checks, etc. will be provided on two-way systems using time sharing techniques to enable available channel space to be used most effectively. Private transmissions will, in most cases, be originated from private sources, stored and retrieved from private data banks, and addressed to unique terminals in the cable system.

Switching systems have a potential for providing such privacy on cable systems. However, currently available designs, such as Dial-a-Program and DISCADE, are controlled by the viewer rather than the sender. Consequently, viewers would have access to all messages on every time-shared private channel, regardless of to whom the messages were addressed. A possible means of overcoming this problem would be to include address-gating as is done in the MITRE TICCIT system.

Another possibility would be to eliminate the local distribution center and to locate a remote channel selector, address decoder and gating circuit in an external unit at the input end of each subscriber's drop-line.

A universal terminal that could be used to receive and provide billing for Premium TV as well as receive private channels and subscription channels is estimated to cost about 10% more than the standard Electronic Information-Handling terminal described above.

The MITRE Digital Communications Cable System

MITRE has developed a system which allows subscribers on a cable system to communicate with each other using digital signals. Actual demonstrations of this system will permit an evaluation of the many speculations about the interaction and mutual interference of channels carrying a mixture of video and digital signals.

Special Services

A number of special applications of cable systems such as those for traffic control, distributed mobile communications systems and automatic vehicle monitoring are examined in Appendix B. Many of these have already been demonstrated using other modes of communications. As an example of the use of cable communications for such systems, a functional schematic of the interface unit which would connect a traffic control system to a cable system has been developed.

DEMAND ANALYSES (Section V)

Demand analyses provide the bridge between the public service objectives of the system and its economic viability. The two purposes of the demand analysis in this report have been:

- To verify community acceptance of the concept of a Washington Cable System, with the specific types of services that it has been designed to provide, at the fees required to make the system economically viable, and
- To gain insights into how to maximize the number of subscribers to the system, which will be a major factor in the development of a socially beneficial and economically viable system.

Several distinct approaches have been taken in this study to estimate the potential demand for services that could be provided by various system options. These are summarized below.

First, a review has been made of previously developed models that use regression analyses to determine which services provided by conventional one-way cable television systems have a significant impact on the demand for such a system. These models identify parameters that need to be given consideration in such a demand analysis. But most of the data were not derived from systems in large cities, and therefore cannot be accurately applied to urban cable systems. Furthermore, they do not address the demand for new and innovative types of services. However, this analysis technique was used to develop estimates of the expected subscriber penetration for the particular case of a Washington Cable System (WCS) that would offer only local or imported off-the-air signals and mechanical originations.

Second, expert opinion has been sought from other cable operators both in the U. S. and Canada, from leading universities in the field and from potential commercial users such as utility and maintenance companies.

Third, market surveys and other data on existing community antenna television systems in the top-25 markets have been reviewed. These indicate a final or asymptotic penetration ranging from 9% to 41% for different cities with subscriber fees ranging from $6.90 to $5.00 per month.

Fourth, Delphi techniques indicate that revenues from future cable communication services may eventually be expected to total about $20 billion per year, with cable communications for computer-aided school instructions, person-to-person paid work at home, and plays and movies from a video library generating almost half of these revenues.

Fifth, a D. C. community survey was conducted by Howard University under contract to The MITRE Corporation. Figure II-7 shows the relationship that was found, between the expected penetration and monthly subscriber fees, for combinations of one-way and two-way services that might be offered by a Washington Cable System. This shows that almost 80% of the households in Washington might be expected to subscribe to the one-way and subscriber-response alternatives, and almost 50% to electronic information-handling if the programming is attractive and the subscriber fees are low enough.

Sixth, new types of two-way services have been demonstrated by MITRE in Reston, Virginia, on a continuing basis since July 1971 and in Dayton, Ohio, at a cable symposium, to gain technical and operational insights on their utilization, and to gather opinions of viewers on the amount that they would be willing to pay for such services. While these results do not apply specifically to Washington, they indicate that only about 20% of those surveyed would be willing to pay up to $22 per month for the full complement of services that might be offered by the WCS. The Howard Survey, as seen from Figure II-7, indicated that about 47% of the Washington residents questioned would be willing to pay this amount for these services.

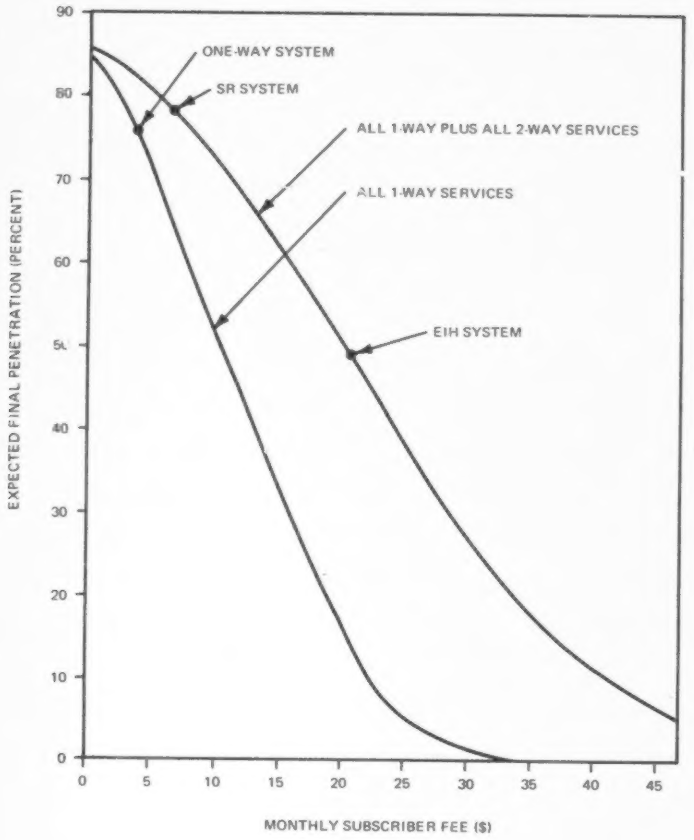


FIGURE II-7
RELATIONSHIP OF EXPECTED FINAL PENETRATION TO
MONTHLY SUBSCRIBER FEE FOR BASE CASES OF SERVICE

Finally, after the construction of the WCS, it is planned that experimental tests will be conducted (e.g., the two-way service demonstrations planned for S/A's 2 and 7) to determine the acceptability of new and innovative services. Continual subscriber-preference data will be obtained from subscriber responses that will indicate their preference for the different types of programming offered on the Washington Cable System.

Table II-4 summarizes various estimates of potential subscriber demand at specified subscriber fees, as a function of the levels of service that could be provided by the Washington Cable System. The potential demand represents the percentage of District residents that might be expected to subscribe to the types of services shown, for the fees specified. For instance, 56% to 76% of the households might be expected to subscribe to the one-way services that could be offered on the first cable, if the subscriber fee is set at $3.50 per month.

Moreover, 63% to 78% of the households might be expected to subscribe to the two-way subscriber-response services on the second cable at an additional fee of $3.00 per month.* This would amount to a total of $6.50 per month for both the one-way services on the first cable and the subscriber-response services on the second cable.

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*This arrangement of separate fees for each cable was suggested in our Interim Report on this study of November 1971, and is being applied in New York City by Sterling Communications.

TABLE II-4
ESTIMATED PENETRATION FOR WCS TELECASTING NET AS A FUNCTION OF SUBSCRIBER FEE AND LEVEL OF SERVICE

LEVEL OF SERVICE	ESTIMATED PENETRATION
A Monthly Subscriber Fee of $3.50 for the Following Services:	
Conventional One-Way Services	
. Local off-the-air signals . Continuous news, time, weather, etc.	18% to 33% penetration
. Imported off-the-air signals	Increase to 24% to 44% penetration
Additional One-Way Services	Increase to 56% to 76% penetration
. Imported cable signals . FM radio . New movies and sports features . Local programming . Educational access . Municipal government access . Public information services . Instructional programming . Health services . Special interest programming . Communications for pay TV, professional channels and other private modes	
An Additional Monthly Subscriber Fee of $3.00 for the Following Services:	
Subscriber-Response Services	63% to 78% penetration
. Interactive entertainment . Interactive education . Preference polling . Catalogue shopping . Communications for alarms . Communications for utility and maintenance services* . Communications for pay TV, professional channels and other private modes	
An Additional Monthly Subscriber Fee of $15.50 to $8.50 for the Following Services:	
Electronic Information-Handling Services	20% to 60% penetration
. Computer-aided instructions . Interactive entertainment . Social services . Video library . Individualized shopping and reservations . Banking and credit . Public information services	

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*In the base cases for the financial analyses (see Section VI), it was assumed that utility and maintenance companies would pay $2 per month per customer, and that the penetration would be 100% for this service.

An interpretation of the Reston, Dayton and Washington data would indicate that from 20% to 60% of the households might be expected to subscribe to Electronic Information-Handling Systems as the additional subscriber fee is varied from $15.50 to $8.50 per month. In other words, these subscribers might be expected to pay a total fee of between $22 and $15 per month for the full complement of services that could be offered by the Washington Cable System, including one-way services, subscriber-response services and electronic information-handling services.

FINANCIAL ANALYSES (SECTION VI)

The basic one-way system proposed for initial implementation is summarized in Table II-5. The five implementation phases treated by the economic model would involve starting a new sector every year over a period of five years. As a result, the period in which system deficits are expected would be longer than would normally be experienced with smaller systems.

Base cases in which two-way subscriber-response services as well as two-way electronic information-handling services were introduced during the fourth year of system implementation were also examined. These are summarized in Tables II-6 and II-7.

A summary comparison of the financial analyses of these base case systems is shown in Table II-8. The total capital cost for installing a one-way system covering the entire city of Washington, D. C., and capable of delivering the services listed in the description of one-way services earlier in this Section, would be about $31 million. About

TABLE II-5
SUMMARY OF BASIC ONE-WAY SYSTEM

- Two Parallel Telecasting Cables, Plus Four Point-to-Point Nets
- First Telecasting Cable, One-Way; 30 Channels, Fully Operational Throughout D. C.
- Second Telecasting Cable, Two-Way (Initially Quiescent Except in S/A 2 and 7); 30 Forward Channels plus 4 Reverse Channels, in S/As 2 and 7 only
- 100 Subscriber Response Terminals in Service Areas 2 and 7 in First Year, 1100 in Second Year, 6100 in Third Year
- Installation: 5 Phases of 1 Year Each
- Total Households Passed: 263,000
- 1222 Total Street Miles: 1074 Miles for Telecasting Net, Plus 148 Miles for Point-to-Point Nets
- Programming Costs, One-Way Services; $0.4M/Year for Basic Programming Costs plus $9.50/Year/Subscriber for Other Programming Costs (see Sections III and VII)
- Final Penetration, One-Way Services; 76% (see Section V)
- Subscriber Fees
    - All One-Way Services
        - First Set; $3.50 per Month per Subscriber
        - Additional; $2.00 per Month per Subscriber
    - Experimental Subscriber Response Services in S/As 2 and 7
        - Each Set; $3.00 per Month per Subscriber
- Rates for Other Services, 10th Year: A Total of $200/Min. for Advertising on 12 Channels; $20/Min./Channel for 12 Leased Telecasting Channels; and $4/Hour/Channel for 100 Leased Point-to-Point Channels
- Revenues from Other Services: $9.28 per Year per Subscriber (i.e., the Equivalent of $3.65/Year/Subscriber from Advertising, $2.45/Year/Subscriber from 12 Leased Telecasting Channels, and $3.18/Year/Subscriber from 100 Leased Point-to-Point Channels).

TABLE II-6
SUMMARY OF BASIC SUBSCRIBER RESPONSE (SR) SYSTEM

. Two Parallel Telecasting Cables, Plus Point-to-Point Nets

. First Telecasting Cable, One-Way: 30 Channels, Fully Operational Throughout D.C.

. Second Telecasting Cable, Two-Way: 30 Channels Downstream Plus Four Channels Upstream, Fully Operational Throughout D. C. After Third Year of System Operation

. 100 Subscriber Response Terminals in Service Areas 2 and 7 in First Year, 1100 in Second Year, 6100 in Third Year. Subscriber Response Terminals for All Subscribers After Third Year

. Installation: 5 Phases of One Year Each

. Total Households Passed: 263,000

. 1222 Total Street Miles: 1,074 Miles for Telecasting Net, Plus 148 Miles for Point-to-Point Nets

. Programming Costs, 1-Way and SR Services: $0.4M/Year for Basic Programming Costs, plus $25.25/Year/Subscriber for Other Programming Costs (see Sections III and VII)

. Final Penetration, 1-Way and SR Services: 78% (see Section V)

. Subscriber Fees:

All One-Way Services plus All Two-Way Subscriber Response Services
First Set; $6.50 per Month per Subscriber
Additional Set; $2.00 per Month per Subscriber

. Rate for Other Services, 10th Year: A Total of $200/Minute for Advertising on 32 Channels, $20/Hour/Channel for 32 Leased Telecasting Channels, $4/Hour/Channel for 100 Leased Point-to-Point Channels, and $2.00/Month/Customer for Utility and Maintenance Services

. Revenues from Other Services: $13.28 per Year per Subscriber (i.e., the Equivalent of $3.65/Year/Subscriber from Advertising, $6.55/Year/Subscriber from Leased Telecasting Channels, and $3.08/Year/Subscriber from Leased Point-to-Point Channels)

TABLE II-7
SUMMARY OF BASIC ELECTRONIC INFORMATION-HANDLING (EIH) SYSTEM

- Two Parallel Telecasting Cables, Plus Four Point-to-Point Nets

- First Telecasting Cable, One-Way: 30 Channels, Fully Operational Throughout D.C.

- Second Telecasting Cable, Two-Way: 30 Channels Downstream Plus Four Channels Upstream, Fully Operational Throughout D.C. After Third Year of System Operation

- 100 Combined Subscriber Response and Frame-Stopper Terminals in Service Areas 2 and 7 in First Year, 1100 in Second Year, 6100 in Third Year. Combined Terminals for 60% of Subscribers, and Subscriber Response Terminals for Remaining 40% of Subscribers, After Fourth Year (see Section V)

- Installation: 5 Phases of One Year Each

- Total Households Passed: 263,000

- 1222 Total Street Miles: 1074 Miles for Telecasting Net, Plus 148 Miles for Point-to-Point Nets

- Programming Costs, All Services: $6M for EIH Computer Programming plus $0.4M/Year for Basic Programming plus $45.25/Year/Subscriber for Other Programming (see Sections III and VII)

- Final Penetration, 1-Way and SR Services: 78% (see Section V)

- Final Penetration, EIH Services: 47% (see Section V)

- Subscriber Fees:

  All One-Way Services, plus All Two-Way Subscriber Response Services, Only
    First Set; $6.50 per Month per Subscriber
    Additional Set; $2.00 per Month per Subscriber
  All Services
    First Set; $22 per Month per Subscriber
    Additional Set; $2.00 per Month per Subscriber

- Rates for Other Services, 10th Year; Same as for Basic Two-Way Subscriber Response System

- Revenues from Other Services; Same as for Basic Two-Way Subscriber Response System

TABLE II-8
SUMMARY COMPARISON OF THE BASE CASE SYSTEMS

SYSTEM CHARACTERISTICS	ONE-WAY SYSTEM	TWO-WAY SUBSCRIBER RESPONSE SYSTEM	TWO-WAY ELECTRONIC INFORMATION HANDLING SYSTEM
Number of Channels			
Telecasting			
Total	up to 30	up to 64	up to 64
Forward	up to 30	up to 60	up to 60
Reverse	4 (SA 2, 7 only)	4	4
Public Access	12	24	24
Imported TV and Cable Signals	5	6	6
Point-to-Point			
Total	150	150	150
Number of Two-Way Terminals			
Total (SR/Combined)			
1st Year	100/0	100/0	100/100
2nd Year	1,100/0	1,100/0	1,100/1,100
3rd Year	6,100/0	6,100/0	6,100/6,100
4th Year	6,100/0	85,668/0	85,668/51,401
5th Year	6,100/0	121,936/0	121,936/73,165
6th Year	6,100/0	152,824/0	152,824/91,694
7th Year	6,100/0	175,395/0	175,395/105,231
8th Year	6,100/0	190,218/0	190,218/114,131
9th Year	6,100/0	199,752/0	199,752/119,851
10th Year	6,100/0	204,124/0	204,124/112,474
Households Passed, 10th Year	262,796	262,796	262,796
Assumed No. of Subscribers, 10th Year	199,724	204,124	204,124
Final Penetration	76%	78%	78%/47%
Capital Expenditures, by 10th Year			
Total	$31.2M	$61.2M	$114.0M
Per Household	$119	$233	$435
Per Subscriber (Average)	$156	$299	$558
Operating Expenses, 10th Year			
Total	$6.72M	$11.1M	$20.1M
Per Household Per Year	$26	$42	$77
Per Subscriber Per Year	$34	$54	$99
Programming Costs			
Total, Ten Years	$15.0M	$34.3M	$58.5M
Per Subscriber Per Year	$9.50	$25.25	$45.25
Installation Fees (65% of Sub.)	$10.00	$10.00	$10.00
Operating Fees			
1st Set, Final Fee	$3.50/Mo./Sub.	$6.50/Mo./Sub.	$22.00/Mo./Sub.
2nd Set	$2.00/Mo./Sub.	$2.00/Mo./Sub.	$ 2 00/Mo./Sub.
FM Radio	no charge	no charge	no charge
Rates for Leased Telecasting Channel	$20/Hr/Channel	$20/Hr/Channel	$20/Hr/Channel
Rates for Advertising	$200/Min/All Chan.	$200/Min/All Cha	$200/Min/All Chan.
Rates for Utility and Maintenance Services	-	$2.00/Mo./Hld.	$2.00/Mo./Hld.
Rates for Leased Point-to-Point Channel	$4/Hr/Channel	$4/Hr/Channel	$4/Hr/Channel
Gross Revenues, 10th Year			
Total	$11.5M	$26.3M	$49.2M
Per Household Per Year	$44	$99	$187
Per Subscriber Per Year	$58	$128	$240
Equity Required (Debt/Equity = 2)	$ 9.9M	$18.7M	39.2M
Loans Required by 10th Year	$22.8M	$35.6M	77.9M
Interest Rate on Loans	8%	8%	8%
Ratio of Operating Expenses to Gross Revenues, 10th Year	0.58	0.42	0.41
Break-Even Points			
Operating Income	4th Year	4th Year	4th Year
Pre-Tax Profit	7th Year	4th Year	4th Year
Coverage of Interest Payments	6th Year	4th Year	4th Year
Minimum Ratio of System Assets-to-Outstanding Debts (min. Year)	1.19 (Year 6)	1.13 (Year 3)	1.07 (Year 3)
Estimated Value of System, by 10th Year	$22.7M	$115.8M	$242.6M
Rate-of-Return on Equity, 10th Year	11.9%	30.2%	28.4%
Rate-of-Return on Investment, 10th Year	0.0%	10.8%	10.3%

$5 million of this capital would be required each year for the first 5 years and the remainder over the last 5 years. Operating costs would be about $7 million in the 10th year of system operation. The internal rate-of-return on equity would rise to about 12% by the 10th year of system operations.

A system with a capability to provide subscriber-response services would require about twice as much capital--i.e., about $61 million with over 40% of this required in the fourth year. Operating costs would be about $11 million in the 10th year of system operation. The rate-of-return on equity would peak at about 65% in the fourth year and decrease to about 30% by the 10th year.

The capital costs of Electronic Information-Handling for 47% of the households and Subscriber-Response for 31% of the households would be almost twice as much again--i.e., about $114 million. Operating expenses would be about $20 million in the 10th year and the rate-of-return on equity would peak at about 41% in the 6th year and decrease to about 28% by the 10th year.

System revenues may be plotted for various combinations of one-way and two-way subscriber response services considered. In general these revenues peak in the 50% penetration region as shown in Figure II-8 for a system that would provide all one-way services and subscriber response services. If, on the same graph, system expenditures as a function of penetration are plotted, it can be seen that the maxiumum dollar surplus or profit area is also in the 50% penetration region.

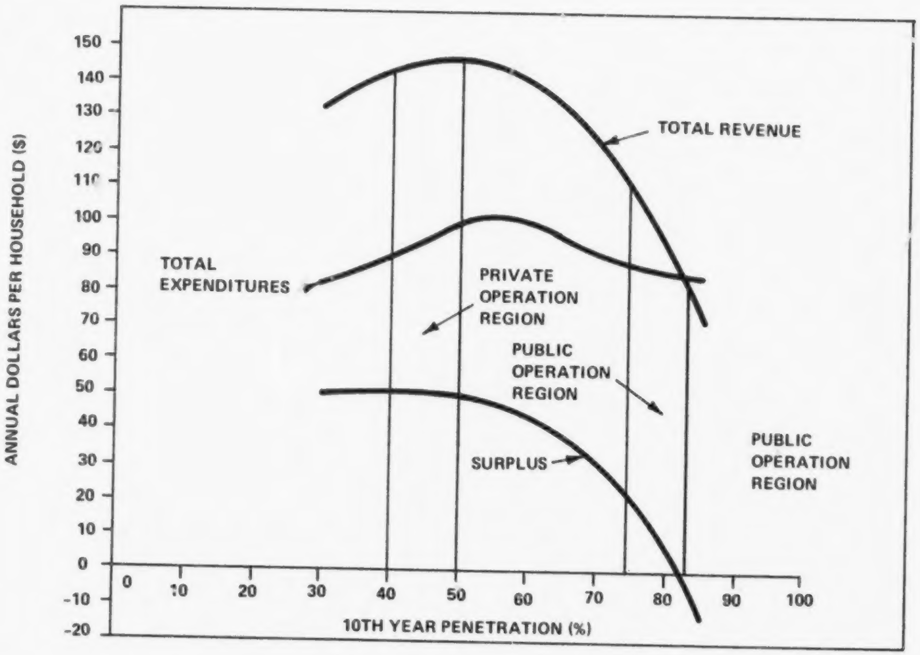

FIGURE II-8
REVENUES, EXPENDITURES AND SURPLUS VS. PENETRATION
FOR CASE OF ALL ONE-WAY PLUS TWO-WAY SERVICES

This indicates that the operators of the cable system must be willing to accept smaller profits if higher system penetrations are to be realized. However, if 100% penetration is to be achieved, some type of public support may be required.

A comparison of the internal rate-of-return on equity, for the three base cases considered, is shown in Figure II-9 as a function of time.

SENSITIVITY ANALYSES (SECTION VII)

The underlying assumptions of a systems analysis are subject to uncertainties that may bias the conclusions if not carefully examined. In order to clearly identify these uncertainties and to determine their possible impact a number of runs have been made with the MITRE economic model. These runs have been designed to test the sensitivity of the results of the financial and economic viability analyses to uncertainties in the assumptions used for the base case alternatives. These uncertainties have been classified in terms of uncertainties in:

- Financial Parameters - Such as, debt-to-equity ratio and interest rates.
- System Parameters - Such as, the subscriber growth curve, number of imported signals, studio costs, other programming costs, capital cost of subscriber terminals, maintenance costs, installation fee, penetration vs. subscriber fee, rate structures, and market value of the system in any given year.
- Organization Parameters - Such as, the number of franchised systems in the city.

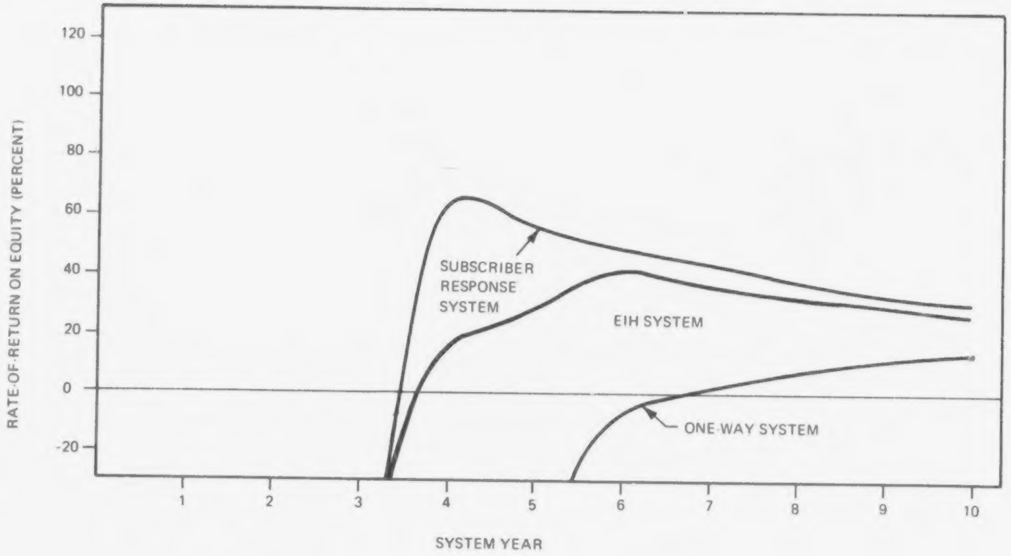

FIGURE II-9
COMPARISON OF INTERNAL RATE-OF-RETURN ON EQUITY
FOR THREE BASE CASE SYSTEMS

Selected results of these sensitivity analyses are summarized in Tables II-9 through II-12. In comparing the results of these analyses, the following points have been noted:

- The interest rate on loans, the debt-to-equity ratio used, and the method of estimating the market value of the system, all have a significant impact on the estimated rate-of-return on equity.
- Uncertainties in the expected system penetration, as a function of subscriber fee, for different levels of service, are probably the most significant system uncertainties in these economic viability analyses.
- The most important uncertainty in determining the capital cost of two-way systems is the cost of the home terminals and, for EIH Systems, the headend computers required for two-way services.
- Low studio costs and low programming costs used in some of the cases shown in Table II-10, show that high rates-of-return might result under these particular conditions. However, it is doubtful that the penetrations indicated by the Howard Survey, at the subscriber fees assumed, could be achieved for urban systems with low costs for studios and other programming facilities and operations. Expanded one-way and two-way programming will almost certainly be required in urban areas to achieve the penetrations assumed in these analyses.

TABLE II-9
SENSITIVITY ANALYSES
TWO-WAY SUBSCRIBER RESPONSE SYSTEMS

FINANCIAL PARAMETER	BASIC VALUES
Debt:Equity	2:1
Interest Rate	8%
SYSTEM PARAMETERS	
Growth Curve	Medium
Number of Imported Signals	6
Studio Costs	$100K/$50K
Other Programming Costs	$25.25/Yr./Sub.
Subscriber Response Terminal Capital Costs[1]	$127/$177 Per Sub.
Installation Fee, 65% of Subscribers	$10/Subscriber
Penetration at Subscriber Fee	78% at $6.50/Mo./Sub.
Leased Channel Rates, 10th Year	
Telecasting, 32 Channels	$20/Hr./Channel
Point-to-Point, 100 Channels	$4/Hr./Channel
Advertising Rates, Incl. All Cablecasting Channels, 10th Year	$200/Min.
Utility, Maintenance, Alarms, Etc. Rates	$2/Mo./Household
Market Value	7 X Operating Income
ORGANIZATIONAL STRUCTURE	
Number of Franchises	1

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[1] Includes cost of set-top converter.

TABLE II-10
BASIC VALUES FOR PARAMETERS USED IN BASE CASE FOR TWO-WAY SUBSCRIBER-RESPONSE SYSTEMS

	EQUITY REQUIRED	LOANS REQUIRED	CAPITAL EXPENDITURES	EQUITY + LOANS / CAPITAL EXPEND.	OPERATING EXPENSES, YR 10	GROSS REVENUES YR 10	OPERATING EXP. / GROSS REV.	EQUITY VALUE, YR 10	RATE-OF-RETURN ON EQUITY, YR 10	CASH BALANCE, YR 10	10 YR PROGRAMMING COSTS	CASH BALANCE / PROG. COST
BASE CASE												
2-WAY SR SYSTEM (CITY-WIDE)	$18.7M	$35.6M	61.2M	0.89	$11.1M	$26.3M	0.42	$115.8M	30.2%	$20.3M	$34.3M	0.59
FINANCIAL VARIATIONS												
DEBT:EQUITY												
1:1	$26.8M	$27.0M	$61.2M	0.88	$11.1M	$26.3M	0.42	$126.1M	25.3%	$24.1M	$34.3M	0.70
5:1	$10.4M	$44.7M	$61.2M	0.90	$11.1M	$26.3M	0.42	$104.9M	40.0%	$16.1M	$34.3M	0.47
INTEREST RATE												
6%	$18.7M	$35.1M	$61.2M	0.88	$11.1M	$26.3M	0.42	$117.9M	30.5%	$20.9M	$34.3M	0.61
10%	$18.7M	$36.2M	$61.2M	0.90	$11.1M	$26.3M	0.42	$113.4M	29.8%	$19.7M	$34.3M	0.57
SYSTEM VARIATIONS												
GROWTH CURVE												
FAST	$19.1M	$36.7M	$61.3M	0.91	$11.1M	$26.4M	0.42	$126.5M	31.7%	$25.7M	$41.6M	0.62
SLOW	$18.6M	$35.7M	$60.5M	0.90	$10.7M	$25.3M	0.42	$109.6M	29.4%	$19.1M	$32.9M	0.58
STUDIO COSTS												
$300K/$100K	$19.0M	$36.0M	$61.9M	0.89	$11.1M	$26.3M	0.42	$115.4M	29.8%	$20.1M	$34.3M	0.59
$1M/$500K	$20.3M	$39.2M	$65.9M	0.90	$11.1M	$26.3M	0.42	$112.3M	28.0%	$18.3M	$34.3M	0.53
OTHER PROGRAM COSTS												
$0/Yr./Sub.	$17.9M	$33.9M	$61.2M	0.85	$5.6M	$26.3M	0.22	$169.3M	38.6%	$31.2M	$3.8M	8.23
$19.25/Yr./Sub.	$18.7M	$35.0M	$61.2M	0.88	$9.9M	$26.3M	0.37	$12d.5M	32.2%	$23.2M	$27.8M	0.86
$31.25/Yr./Sub.	$18.8M	$36.2M	$61.2M	0.90	$12.3M	$26.3M	0.47	$103.0M	28.0%	$17.4M	$41.6M	0.42
SUBSCRIBER RESPONSE TERMINAL CAPITAL COSTS												
$127/Sub	$17.3M	$34.1M	$56.9M	0.90	$11.0M	$26.3M	0.42	$116.7M	31.9%	$20.9M	$34.3M	0.61
$277/Sub.	$31.4M	$56.3M	$87.6M	1.00	$11.4M	$26.3M	0.43	$92.0M	18.9%	$19.8M	$34.3M	0.58
PENETRATION AT SUB FEE												
75% at $8/Mo.	$18.2M	$34.3M	$60.7M	0.87	$10.9M	$29.1M	0.38	$146.3M	35.4%	$27.1M	$33.1M	0.82
50% at $8/Mo.	$14.9M	$28.5M	$47.8M	0.91	$ 8.4M	$21.5M	0.39	$103.4M	31.8%	$17.5M	$23.4M	0.75
UTILITIES, ETC. RATES												
$0/Mo./Hhld.	$20.0M	$42.2M	$61.2M	1.02	$10.8M	$20.0M	0.54	$43.1M	12.2%	$5.1M	$34.3M	0.15
$3/Mo./Hhld	$18.5M	$34.5M	$61.2M	0.87	$11.2M	$29.5M	0.38	$49.2M	35.1%	$27.7M	$34.3M	0.81
MARKET VALUE												
5 X Oper Income	$18.7M	$35.6M	$61.2M	0.89	$11.1M	$26.3M	0.42	$85.3M	24.7%	$20.3M	$34.3M	0.59
10 X Oper Income	$18.7M	$35.6M	$61.2M	0.89	$11.1M	$26.3M	0.42	$161.5M	36.4%	$20.3M	$34.3M	0.59
ORGANIZATIONAL VARIATIONS												
MULTIPLE FRANCHISES, 5 (7[illegible] PEN. AT $6.50/MO/SUB)												
SECTOR 1	$ 3.7M	$ 8.0M	$12.9M	0.91	$ 2.4M	$ 5.9M	0.41	$30.5M	26.3%	$ 6.0M	$ 9.5M	0.63
SECTOR 2	$ 3.3M	$ 7.1M	$11.4M	0.91	$ 2.3M	$ 5.0M	0.46	$22.9M	23.9%	$ 4.1M	$ 8.8M	0.47
SECTOR 3	$ 4.0M	$ 7.4M	$13.7M	0.82	$ 2.3M	$ 6.4M	0.40	$36.1M	27.7%	$ 9.1M	$11.3M	0.81
SECTOR 4	$ 4.2M	$ 7.9M	$16.0M	0.76	$ 3.0M	$ 6.9M	0.43	$35.8M	26.7%	$ 8.5M	$13.0M	0.65
SECTOR 5	$ 1.8M	$ 3.8M	$ 6.3M	0.89	$ 1.4M	$ 2.2M	0.64	$ 4.9M	11.7%	$ 0.1M	$ 4.6M	0.02

TABLE II-11
BASIC VALUES FOR PARAMETERS USED IN BASE CASE FOR ELECTRONIC INFORMATION-HANDLING SYSTEMS[2]

SYSTEM PARAMETER	BASIC VALUES
Capital Cost of EIH Terminals	$427/Subscriber
EIH System Penetration at Subscriber Fee	47% at $22 Mo./Subscriber
Maintenance Factor	8% of Capital Costs
Other Programming Costs	$45.27/Year/Subscriber
ORGANIZATIONAL STRUCTURE	
Number of Franchises	1

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[2] Other basic values same as for the base case for Subscriber Response System (see Table VII-3).

[3] Includes cost of set-top converter and Subscriber-Response unit.

TABLE II-12
SENSITIVITY ANALYSES
ELECTRONIC INFORMATION HANDLING SYSTEMS

BASE CASE	EQUITY REQUIRED	LOANS REQUIRED	CAPITAL EXPENDITURES	EQUITY + LOANS / CAPITAL EXPEND	OPERATING EXPENSES, YR. 10	GROSS REVENUE YR. 10	OPERATING EXP. / GROSS REV.	EQUITY VALUE, YR. 10	RATE-OF-RETURN ON EQUITY, YR. 10	CASH BALANCE, YR. 10	10 YR. PROGRAMMING COSTS	CASH BALANCE / PROG. COST
BASE CASE												
EIH SYSTEM (CITY-WIDE)	$39.2M	$77.9M	$114.0M	1.03	$20.1M	$49.2M	0.41	$209.4M	28.4%	$46.8M	$58.5M	0.80
SYSTEM VARIATIONS												
EIH SYSTEM TERMINAL COSTS												
$327/Sub.	$34.7M	$67.3M	$101.7M	1.01	$19.6M	$49.2M	0.40	$229.1M	31.9%	$47.2M	$58.5M	0.82
$627/Sub.	$49.8M	$101.2M	$138.7M	1.08	$21.1M	$49.2M	0.43	$171.9M	21.2%	$46.0M	$58.5M	0.79
EIH SYSTEM PEN AT SUB. FEE												
20% at $22/Mo.	$36.3M	$70.4M	$ 99.2M	1.08	$18.9M	$35.0M	0.54	$ 87.9M	14.4%	$18.5M	$58.5M	0.32
37% at $26/Mo.	$36.3M	$70.9M	$106.1M	1.01	$19.8M	$49.1M	0.40	$221.1M	30.5%	$46.5M	$58.5M	0.79
53% at $18/Mo.	$42.3M	$83.2M	$118.9M	1.05	$20.2M	$45.4M	0.44	$216.0M	22.8%	$39.1M	$58.5M	0.67
60% at $15/Mo.	$48.1M	$97.0M	$129.4M	1.12	$20.5M	$42.2M	0.48	$115.8M	14.8%	$32.3M	$58.5M	0.55
O&M FACTOR												
5%	$38.1M	$71.4M	$114.0M	0.96	$16.7M	$49.2M	0.34	$255.3M	32.7%	$51.4M	$58.5M	0.88
11%	$42.7M	$86.8M	$114.0M	1.14	$23.5M	$49.2M	0.48	$166.0M	23.0%	$42.1M	$58.5M	0.72
14%	$49.1M	$98.5M	$114.0M	1.29	$26.9M	$49.2M	0.55	$137.2M	16.0%	$37.5M	$58.5M	0.64
OTHER PROGRAM COSTS												
$35.25/YR./SUB.	$39.1M	$76.3M	$114.0M	1.01	$18.1M	$49.2M	0.37	$232.1M	30.4%	$51.6M	$46.4M	1.12
ORGANIZATIONAL VARIATIONS												
MULTIPLE FRANCHISES, 5 (78%/47% PEN at $6.50/$22 Per Mo. Per Sub.)												
SECTOR 1	$8.0M	$15.5M	$24.8M	0.99	$4.4M	$11.1M	0.40	$58.0M	24.9%	$12.4M	$16.6M	0.75
SECTOR 2	$6.9M	$13.6M	$21.[illegible]	0.96	$4.0M	$ 9.3M	0.43	$46.7M	23.7%	$ 9.5M	$14.8M	0.64
SECTOR 3	$8.6M	$16.0M	$26.7M	0.92	$4.8M	$12.1M	0.40	$66.8M	25.6%	$15.9M	$19.4M	0.82
SECTOR 4	$9.0M	$16.8M	$29.5M	0.88	$5.3M	$12.8M	0.41	$68.6M	25.3%	$15.9M	$21.2M	0.75
SECTOR 5	$3.4M	$ 6.5M	$10.6M	0.93	$2.2M	$ 4.1M	0.53	$15.3M	18.4%	$ 1.8M	$ 7.3M	0.25

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- A fast growth curve can increase the rate-of-return on equity by significant amounts over cases using medium or slow growth curves. This emphasizes the importance of providing demonstration projects and market surveys, prior to system implementation, that will determine the most acceptable mixtures of services, before investing large amounts in the construction of sophisticated, large-scale cable communication systems in urban areas, since once the full system is completed, operation should be in a position to offer services, as soon as possible, that will maximize the system penetration.
- The cost of system maintenance, and, in particular, home terminal maintenance is a very important factor in determining the economic viability of a sophisticated two-way urban cable system since such a large fraction of the total capital expenditures is for the home terminals. This emphasizes the need for both reliable equipment and remote maintenance checking of this equipment through the use of the cable system.
- The maximum possible economies-of-scale in the purchase of cable amplifiers and terminals are probably attained by the size of the franchise sectors that have been selected for this study. However, further economies-of-scale

in studio costs, management costs, programming costs, and other operating costs could probably be attained with a single large system operating under a citywide franchise, rather than with a number of small systems operating under several franchises.

The granting of multiple franchises for one-way systems in Washington, D. C. would probably result in low economic viability in at least two of the five Sectors into which the city was divided, if the Service Area constructions selected here are used in the final partitioning of the city into franchise areas. These problems arise as the result of the high cost of duct-work required for underground cable installation in the central city. This does not exclude the possibility of subdividing the city in other ways which might result in economic viability for all sectors. This, however, was not attempted in the study reported here.

This lack of economic viability in these two sectors could probably be overcome if the franchises required that two-way services be provided that could achieve high public acceptance at the subscriber fee stipulated. However, such systems would require considerably higher capital costs and programming budgets than one-way systems.

These results strongly suggest the need for tests, demonstrations, and market surveys to resolve the problem of how to best implement urban cable systems and to provide the new types of programs and services that they are capable of producing. It is clear that the key to the financial success and social usefulness of urban cable systems lies in fulfilling current communications needs, and delivering new programming and services at prices that are acceptable to the potential users of the system.

DEMONSTRATIONS OF PROGRAMMING AND SERVICES

To meet these needs the WCS would mount extensive tests and demonstrations of programming and services, involving all three basic levels of the system capability--i.e., One-Way transmission, Subscriber-Response, and Electronic Information-Handling. The tests and demonstrations would involve most or all of the kinds of programming and services set forth above in the description of these three levels of capability. A market survey would be associated with each demonstration to determine the price that subscribers are willing to pay for the programs and services tested.

Community Programming

One-way transmission experiments would involve substantial testing of community programming, which is one of cable's greatest areas of potential benefit. A number of cable systems have made channel space available, either without charge or on a leased basis, to individuals and community groups. Results, however, have sometimes been minimal in terms of the quality of the material and the public interest in the programming. The problem is to provide both technical and production assistance to a whole stratum of the citizenry that has previously had little or no direct access to television, and knows very little about how to use it. The demonstration project would therefore include the establishment of five Production Assistance Teams, who would make themselves available to all community cablecasting studios. These teams would help individuals and community groups to turn their ideas and their interests into effective visual programming.

Subscriber-Response

As an example of the Subscriber-Response two-way system, one demonstration would be used for automatically interrogating a number of different types of sensors that would be placed in homes and offices throughout the city. These would include utility meter reading devices, burglar, fire and other alarms, and maintenance checking devices to determine whether electrical and other devices are functioning properly.

The system in effect would repeatedly "ask" these various types of automatic devices and alarms installed throughout the network whether certain things are occurring. The interrogation takes the form of transmission of coded impulses throughout the system. The sensors respond with answering impulses under certain conditions. Thus a fire alarm would respond in the event of fire, and a burglar alarm in the event of entry through a window or door.

The key to the success of this automatic interrogation process is cable's broadband signal-carrying capacity, and its resultant ability to "sweep" a large system rapidly with the querying impulses. As described in Section IV a single central processing unit could sequentially query and receive responses from up to 24 different types of sensing devices and the subscriber-response terminal in every household, office, business establishment, and industrial site, up to the number of 300,000 different terminal sites, at a rate of about one complete sweep every minute. Sensors that could be queried, in addition to fire and burglar alarms, could include utility meters, oil tank level indicators, alarms to indicate gas leaks, oil leaks or water leaks, and sensors to measure pollution level.

Electronic Information-Handling System

In testing and demonstrating two-way Electronic Information-Handling, both visual and non-visual uses of the system would be developed. Subscriber interaction with educational programming would be developed in cooperation with public schools and institutions of higher education in the Washington area.

An example of this is in the area of vocational and technical education. In Washington, many more secondary students apply for vocational education every year than the District's vocational schools can accommodate. Such equipment and facilities as these schools possess, is frequently inadequate or outdated. In addition, little or no provision exists for updating the skills of graduates once they have left school. Finally, the schools have little capacity to reach into communities and neighborhoods to provide skills to the underemployed and unemployed.

Both the Washington Technical Institute and the D. C. Public School System are highly interested in developing and testing interactive educational programs, including Computer-Assisted Instruction, for use in schools, community centers, and homes, to deal with the problem of vocational education and training. The cable system will provide a demonstration matrix for testing applications of CAI. Frame-stopping terminals can also make possible the simultaneous transmission of numerous different courses and lectures to any given number of classrooms in schools throughout the district, and to any given number of community centers, all on the same TV channel.

Special Services

The fourth demonstration program would be an Automatic Vehicle Monitoring (AVM) demonstration. There is a shortage of radio spectrum space for mobile radio communication. A feasible solution to this shortage is to limit the power of local transmitters so that transmitted signal strength is very low except in the immediate geographical vicinity. This configuration would require many fixed transceivers fairly closely spaced together, and all connected to a master switching and control center by the WCS cable network. Many streetside sensors would be interconnected by the two-way capability of the cable system.

With a large number of fixed receiving stations of this type, moving vehicles can also be located by signal direction, strength, and triangulation. Thus this same system can be used as an Automatic Vehicle Monitoring system to determine the location of police cars, taxis, and as a mobile radio communications demonstration if the number of "calls" were expanded where about seven different frequencies are used within each geographic area.

Point-to-Point Networks

Data exchange among hospitals and other health facilities to improve the delivery of health services and health care would be provided in the fifth demonstration. This program would test the use of telediagnosis between hospital and community health clinics, housing project locations, mental health, and narcotics administration facilities.

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Total cost of mounting these five demonstrations would be about 4.7 million dollars. This includes capital expenditures and operating costs for up to three years of demonstrations and market surveys.

At the end of the system's fifth year of operation, results of the completed tests, demonstrations, and market surveys would be assessed. Programming and services that prove viable and socially useful would be installed as permanent features of the Washington Cable System.

SECTION III

PROGRAMMING AND SERVICES

INTRODUCTION

Because of its role as the Federal City, Washington, D.C. has a special significance as a national showplace. The upcoming Bicentennial Celebration in 1976 is a particularly attractive target date by which to have the Washington Cable System operational. This system would serve as a model for other cities to demonstrate that such a telecommunications system, with a special focus on enhanced urban communications, can aid in improving the city's quality of life. This section presents some general examples of how cable systems might be involved in many aspects of urban life in the near future by providing new types of services and programming. While this is not an exhaustive listing, we have tried to be comprehensive in terms of presenting a broad range of possibilities, using Washington, D.C., as a specific example. Table III-1 indexes these services for easy reference. Table IV-5, in the next section, indicates possible channel allocations and programming requirements.

NEEDS AND OPPORTUNITIES

The impact of mass communications (especially television) upon all segments of the population has been the subject of much controversy in recent years. Many reports have been issued which heavily criticize current programming by over-the-air broadcasters, notably by the

TABLE III-1
INDEX OF SERVICES

TELECASTING

- ONE-WAY
  - LIMITED ONE-WAY
    1. Local Signals
    2. Imported Signals
    3. Continuous News, Time, Weather, FM Radio
    4. Movies and Sports
    5. Local Programming
    6. Educational Access
    7. Municipal Government Access
    8. Leased Channels
    9. Instructional Programming
    10. Health Services
    11. Special Interest Programming
  - FULL ONE-WAY
    1. Public Information Services
    2. Professional Channels
    3. Pay TV
- TWO-WAY
  - LIMITED TWO-WAY
    - SUBSCRIBER-RESPONSE
      1. Interactive Educational
      2. Interactive Entertainment
      3. Preference Polling
      4. Catalog Shopping
      5. Alarm Communications
      6. Utility and Maintenance Services
    - ELECTRONIC INFORMATION-HANDLING
      1. Computer-Aided Instruction
      2. Interactive Entertainment
      3. Social Services
      4. Video Library
      5. Individualized Shopping and Reservation
      6. Banking and Credit
    - SPECIAL
      1. Traffic Control
      2. Mobile Radio Communications and Automatic Vehicle Monitoring
      3. General Purpose Digital Communications
      4. Local Distribution for Special Common Carrier Services
  - FULL TWO-WAY

POINT-TO-POINT

1. Municipal Government
2. Federal Government
3. Colleges and Universities
4. Business and Commerce

President's Commission on Crime and Violence,[1] the White House Conference on Children,[2] and the National Advisory Commission on Civil Disorders.[3] The thrust of these criticisms is that television tends to exaggerate reality in both news coverage (in spite of good intentions to present a fair and accurate picture) and entertainment programming. These exaggerations are often perceived as reality by those viewing these programs. Furthermore, in terms of both news coverage and entertainment the media fails to fulfill many of the expectations or desires of blacks and other minority groups in terms of program content.

A comprehensive study[4] by the University of Michigan's Department of Communications of mass media usage by both the urban poor and the general population further substantiates the findings of these reports. A brief summary of their observations follows:

. Children. The average number of working TV sets is two per family for all race and income groups. Black children watch more television than white children. Poor children watch more TV than middle-income children. Low-income black children report an average of seven hours of TV viewing per weekday and less parental control over TV watching than do middle-income children. Low-income children are more likely to believe that TV content is "true-to-life" and are more likely to state that they watch television to learn--about things not taught in school, about new things, about how to solve problems and about how to act. Black youngsters are even more inclined to report these items than white youngsters.[5]

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[1] Report To The President, National Commission on the Causes and Prevention of Violence, Washington, D. C., 196

[2] Report To The President, White House Conference on Children, Washington, D. C., 1970.

[3] Report of the National Advisory Commission on Civil Disorders, March 1, 1968.

[4] Greenberg, B. and Dervin, B., Use of the Mass Media by the Urban Poor, Praeger Publishers, 1970.

. Adolescents. Low-income teenagers watch more television (blacks, 6.3 hours per weekday; whites, 4.6 hours per weekday) than middle-income teenagers (3.7 hours per weekday). Low-income blacks indicate a greater belief in television as depicting reality than do middle-income teenagers. TV is rated by all race and economic groups as the most reliable and believable source of news. Lower class respondents are more likely to use TV as a means of finding out "what life is about." Lower-income black adolescents list TV as a leading source of information about dating behavior.[6]

. Adults. The degree of ownership of TV sets is about the same for all race and economic groups. The availability or ownership of other media forms (newspapers, magazines, radios,

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[5] Ibid., p. 70.

[6] Ibid., pp. 46, 47.

> phonographs, movies) is significantly lower for the lower-income groups than television. The low-income group rates TV as a more believable source of news than do the middle-income groups. Low-income viewers watch TV an average of 5.2 hours per weekday as compared to 2.0 hours per weekday for the middle-income group. The popularity rankings of TV programs are quite different and uncorrelated between the two income groups.[7]

Other results reflecting media usage of all age groups, but differentiating by race and income, show that blacks watch more television than whites; whites use newspapers, radio, and magazines to a greater extent than blacks; blacks show a greater usage of phonographs and higher ownership of phonograph records. Furthermore, this study reviewed interpersonal communications differences between race and income groups. It was found that blacks rely heavily upon word-of-mouth communication, which suggests that the mass media do not adequately cover the interests and needs of the black community. Additionally, the disproportionate ownership and use of phonographs among blacks suggests that the media do not supply enough cultural programming for their specific interests.

The data summarized above are particularly significant since Washington's population is 71% black, a higher percentage of blacks than any of the other top TV markets. One-half of the population has an income of $9,096 or less per year. Fourteen percent of the households are considered poverty-level. When considering these factors in conjunction with the University of Michigan study, it is plausible to assume that television viewing by the Washington population is higher than that of the general population, and, at the same time the programming needs of this predominantly black population are inadequately met.

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[7] Ibid., pp. 79, 80

The implications of the above studies for an urban telecommunications cable system are many. Television, today, is the most powerful form of the media in reaching all economic, racial, and age groups. It exerts an even more powerful influence upon black and lower-income groups and evidence suggests that current programming does not meet the needs of these groups.[8] Current over-the-air broadcasting must program for mass audiences--a problem of channel scarcity. With the channel abundance afforded by an urban telecommunications cable system the problem is the opposite--what are the media needs of small and localized audiences and how can the multifold increase in channel capacity be most effectively used in meeting these needs and in providing increased services? Table III-2 illustrates one potential series of programs suggested for the Bedford-Stuyvesant area in New

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[8] In 1969, a Washington-based organization, Black Efforts for Soul in Television, filed a petition to deny the application for license renewal of one of the major Washington TV stations. One basis for their complaint was failure to be responsive to the needs of minority groups. FCC File BRCT-23.

TABLE III-2
SUGGESTED PROGRAMMING–BEDFORD-STUYVESANT

- Job-A-Rama: Job opportunities, instruction in job interview techniques and preparation of application, other employment services.

- Children's Playhouse: A light educational background for pre-school children.

- Area Center Parade: Explanation, documentation and advertisement of community center activities, transmission of special programs instituted by the various community centers.

- Street Scene: A roving-reporter presentation of "what's going on in the community," as a means of building community identity.

- The Consumer: Bargain hunting, shopping techniques, money-saving hints.

- Kings County Hospital: To create wider attention of endemic health problems and to assist in methods for their eradication.

- Brooklyn College Journal: To provide training, on the cable, in all phases of broadcasting, from administration to production.

- Restore Digest: Community self-help programs prepared by the Restoration Corporation.

- The Drug Scene: Documentaries pointing out the dangers of addiction and the roads to rehabilitation.

- The Black Man: A programming effort highlighting the Black cultural heritage.

- Gospel Hour: Incorporating religion and music into the same production format; reinforcing the activities of the 300 store-front chapels in the community.

- English Lessons: For those conversant only in Spanish.

- Pratt Institute Hour: Devoted to artistic instruction, based at the local Pratt Institute, which specializes in such instruction.

Source: On the Cable: The Television of Abundance, Report of the Sloan Commission on Cable Communications, McGraw-Hill Book Company, 1971, pp. 101, 102.

York. As suggested by this listing, there is great variety in the types of programming that can be offered over cable.

As the Sloan Commission Report states, "Television of abundance is not merely an augmented television of scarcity. A whole new range of possibilities suddenly appears."[9] The report goes on to liken cable to the printing press in that it can be directed towards a wide variety of uses: a medium for entertainment, information and education; a forum for politics and opinion; an intermediary in the provision of almost every kind of service, public and private. Carrying the analog further, the report points out that cable, like the printing press, can be directed to a wide variety of audiences, national, regional, or local; it can be occasional; cable has financial flexibility because it does not exclusively rely on either the advertiser, the subscriber, or the purchaser of its services for an economic base.[10]

A widely accepted set of objectives for television has been developed from the Federal Communications Act:[11]

(1) The structure of the industry should make it possible to cater to as wide a variety of tastes as possible, the tastes of small audiences and mass audiences, of cultural minorities and of cultural majorities. Ours is a pluralistic society, in culture as well as in

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[9] On the Cable: The Television of Abundance, Report of the Sloan Commission on Cable Communications, McGraw-Hill Book Co., 1971, p. 43.

[10] Ibid., pp. 43-45.

[11] As reported in Final Report, President's Task Force on Communications Policy, 1968, Chapter 3, pp. 3, 4.

the ethnic origins and the life-styles of its people. A medium of expression as pervasive as television should reflect and enrich this cultural pluralism.

(2) Television should serve as varied as possible an array of social functions, not only entertainment and advertising, important as they are, but also information, education, business, culture, and political expression.

(3) Television should provide an effective means of local expression and local advertising, to preserve the values of localism and to help build a sense of community, both locally and nationally.

(4) To promote these ends, the cost of access to the broadcast medium for individuals or groups who desire access to viewers should be as low as possible.

(5) Television has become so fundamental a medium of communication in our society that we must seek to make it available to as many people as possible, rural as well as urban, poor as well as affluent. Hence, unnecessary cost barriers to viewing should be avoided.

(6) The fundamental values of a democratic, pluralistic society require that, within the limits of the spectrum, and of economic realities, policy should guard against excessive concentration in the control of communications media.

While broadcast television has fallen noticeably short of these objectives, cable television offers another avenue to achieve these goals. Just how they can be implemented is of utmost importance in designing urban cable systems. The following subsections provide a preliminary discussion of how the Washington Cable System could address the communications needs of the residents and institutions of the District by providing increased and more efficient services and programming.

These services are arranged to reflect the increasing levels of capability of the three basic systems defined in Appendix B: one-way, subscriber response and electronic information-handling. In addition, examples are given of full two-way and point-to-point services. Many of the services discussed below can be provided by any one of the basic systems; however, services have been added on an incremental basis as they require the additional capabilities of two-way and frame-stoppers. For example, special interest programming has been listed under Limited One-Way because these programs can be adequately provided in that mode. However, more efficient delivery of an increased quantity of services could be provided by the more advanced configurations.

ONE-WAY SERVICES

Limited One-Way

Limited one-way services are those which can be provided by a conventional one-way cable system. Many of these services could be provided as soon as the cable system becomes operational and would greatly expand the selection of television programming available.

(1) Improved television reception where it is now poor. The reception of local signals (including Baltimore) is poor, due to shadowing and multipath reflections in about 15-20 per cent of the households in the District of Columbia particularly in Service Areas 8 and 9.

(2) Importation of additional broadcast TV, ETV and cablecast signals. The new FCC rules would permit the importation of two distant signals into the Washington market, as well as an unlimited number of foreign language stations and cablecast originations. Any number of ETV channels can also be imported unless opposed by local ETV stations or educational television authorities.

(3) Continuous news, time, weather, FM radio. A variety of so-called mechanically originated programming can provide continuous information on the news, time, weather, stock market, and cable program guide. Channel abundance allows retransmission of FM radio stations.

(4) Movies and sports. Two of the most popular offerings on cable systems are movies and sports events, both amateur and professional. Future projections indicate that cable could become a major distribution medium for motion pictures. New movies were first in a ranking of services from the Howard Survey. Interview results indicated substantial interest in this feature, with 75% of the respondents willing to pay an additional fee. (See Section V - Demand Analyses.)

The availability of channel space would mean that more local sports events, such as high school basketball games or P.A.L. baseball, could be televised. In addition, carriage of professional and amateur sports could be increased. Tennis and soccer, for example, are drawing more attention while still lacking the mass audience appeal of organized sports like professional football or baseball. Cable could provide an outlet for greater coverage of many type of sports events which now are not carried over broadcast television.

(5) Local programming by community groups about the community and for the community (Public Access Channel). The new FCC regulations require that at least one channel be specially designated and maintained for public access use in the major markets. This channel is to be available on a first-come, nondiscriminatory basis. The cable system is required to maintain and have available for public use at least the minimal equipment and facilities necessary for the production of programming.[12]

To initiate operation of its public access channel, Sterling-Manhattan in New York telecast on one channel for an entire weekend using 1/2 inch video tapes made about the East Village by people who resided there.[13] The taping process and subsequent viewing gave the residents more information about, and awareness of, the people and events within the community and fostered greater community spirit.

Other local programming could spring from local theatre groups or "soapbox" programs featuring anyone who wanted to voice his opinion.

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[12] Code of Federal Regulations, Title 47, Chapter 1, Part 76 - Cable Television Service, Subpart G - Cablecasting, Section 76.251(a)(4).

[13] R.E.D. Burns, The Alternative Media Center, at the NCTA Annual Convention session on "The Educator and CATV: Possibilities for Partnership," Washington, D.C., July 7, 1971.

The provision is especially important to groups and people who now have no access to, or control over, the media. It provides a forum for a diversity of voices within the community. Public Access Network has recently been formed in Berkeley, California, to act as a clearinghouse and distribution center for local cable programming. They also plan to train community people (in cable systems who affiliate with them) in the production and financing of local origination.[14] Table III-3 cites a wide variety of local origination programming offered on Canadian cable systems.

(6) Education access channel. Cable systems (in the major markets) are also required to maintain at least one specially designated channel for use by local educational authorities.[15] In testimony before the D.C. Manpower and Economic Development Committee, one official cited the following uses of cable by the D.C. Public Schools: telecast of Board of Education meetings, community participation programs, pre-school programming, adult education, and home-school communications.[16] As indicated by these remarks, the range of potential educational applications is extensive. It seems apparent that a single channel will hardly begin to meet the expected future demand.

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[14] Broadcasting, February 21, 1972, p. 32.

[15] Code of Federal Regulations, Title 47, Chapter 1, Part 76 - Cable Television Service, Subpart G - Cablecasting, Section 76.251(a)(5).

[16] Greene, J. Weldon, "CATV and Its Implications for Instructional Television (ITV) in the District of Columbia." Testimony before the Manpower and Economic Development Committee of the D.C. City Council, November 13, 1970.

TABLE III-3

LOCAL ORIGINATION PROGRAMMING ON CANADIAN SYSTEMS

- Professional sports such as hockey, boxing, and football balcked out locally. Pee-wee and semiprofessional games have also been presented, as well as college games blacked out locally.
- Activities of service organizations (e.g., Kiwanis, Red Feather, and Rotary Clubs).
- Kindergarten shows arranged to entertain and educate preschool children
- Women's programs: fashion shows, modeling tips, beauty hints, etc.
- General homemaking advice for women.
- Knitting and weaving instruction.
- Home furnishing and interior decorating for the low-budget housewife.
- Swap-shop programs
- Calisthenics and physical culture
- Home first aid taught by an organization similar to the American Red Cross.
- Career guidance for woman, including job and schooling opportunities.
- Animal care, given by a veterinarian.
- Gardening.
- University programs.
- Discussion of books with popular authors.
- Information on local recreational opportunities--movies, theaters, places to visit, etc.
- Concerts and variety shows .
- Popular music programs.
- Language lessons.
- Public speaking.
- Travelogue series.
- Tax-return advice.
- Continuing education and trade counseling for teen-age dropouts and adults.
- Talks by police on highway driving safety, regulations, and automobile maintenance advice.
- Discussions of drug use and abuse.
- Interviews with members of Alcoholics Anonymous, Smokers Anonymous, Weight Watchers, Gamblers Anonymous, and ex-prisoners.
- Automobile maintenance information.
- Information on the use and care of snowmobiles.
- Photography and cinematography instruction.
- Instruction in buying and caring for guns.
- Coverage of the industrial and business growth of the community, with an analysis of ensuing sociological changes.
- Programs sponsored by religious groups.
- Talks by members of the fire department on fire prevention and safety.
- A weekly half- or one-hour videotaped guided tour of the local art gallery.
- Foreign-language news programs for minority groups.
- Foreign-language programs providing assistance to immigrants.

Source: Feldman, N., "Cable Television: Opportunities and Problems in Local Program Origination." The RAND Corporation, R-570-FF, September 1970.

However, experimentation with the medium and the development of the necessary programming will take some time to implement. In addition, some organizational and operational changes will probably be required to stimulate the use of cable as an effective educational tool. As the Sloan Commission comments it may not be ..."a question of what cable television can add to the formal educational process, but as the broader question of how the entire process changes when a powerful new tool of communications is added. It may well be that in the light of the new tool, every major aspect of the system requires significant change..."[17]

Since the list of educational applications is virtually endless and encompasses a large number of varied institutions, this section will only present a brief, illustrative sampling of what could be done within the public school system. Other applications, such as higher education, professional training, and various specialized educational uses will be discussed in later sections.

Schedule Flexibility

Multiple channels permit the use of televised materials when the teacher is ready to use them rather than restricting class schedules to conform with program availability via broadcast TV. A cable system can retransmit educational television (ETV) and instructional television fixed service (ITFS) on a delayed time schedule and with more nearly an on-demand type of response. Multiple channel capability also means that in-service training materials can be made available when teachers are ready to use them.

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[17] On the Cable, op. cit., p. 108.

Telecast to Homes and Schools

Telecasting to homes allows the school system to more readily reach and teach the homebound student as well as others who may be absent from school. It may be able to compensate for time ordinarily lost due to bad weather or some other occurrence which closes the schools. Programming could consist of simply televising a typical class room or special instructional materials presented from a studio.

Retransmission of ITFS and ETV

Many schools cannot receive either ITFS or ETV channels. A cable system can retransmit these channels to all schools, as well as give the added capability of presenting these programs on a flexible schedule through delayed presentation.

Local Production

Local origination allows the production of both instructional material and special programs by students and staff. For example, a chemistry class may stage an experiment which could then be shown in other schools and classes. Similarly, dramatic and musical productions could be distributed throughout the school system or even throughout the community. Such local production need not lack the quality of commercially provided materials and can be much less costly. Many students who find school boring get "turned on" by producing their own materials.

Parent and Tax-Payer Information

Through the cablecast network the community-at-large can be kept informed of what's happening in the schools. Many criticisms of the educational system are based on incorrect or scant information which PTAs and newsletters, etc., have not been very effective at countering. In addition, cablecasting allows getting information to every home, including those taxpayers without school-age children who may otherwise have little or no contact with the schools.

In-Service Training

As mentioned above, cable with its multichannel capability is an ideal medium for the efficient distribution of specialized programming within a flexible schedule. Through the use of an uncomplicated and familiar device, the TV set, teachers can receive special training and professional programming either in their own free time (even in their home) or in time allowed during the school day for staff development.

Multi-Language Programming

Many large cities face the difficulty of teaching large groups of children whose native language is something other than classroom English. Washington, for example, has a large Spanish-speaking community. Not only does TV provide a good medium for teaching English to these children, but programming in other subject areas could also be provided in their native language, so that they need not do poorly in school because of language barriers. Many relatively small communities of interest can be provided with a degree of programming on the cable that is not otherwise economically practical.

Expanded Curriculum

Demand for new and specialized courses which may have a relatively short life in the curriculum present a problem of finding teachers who are qualified to teach them. Using the cable as a distribution medium, a smaller number of teachers could present special courses throughout the school district and thereby meet the changing demands for new subjects.

On the other hand, there may be a demand for advanced courses which is not large enough in any one school to justify being a regular course offering, but for which a class-size demand might exist in an entire district. For example, an advanced math course may be of interest to only a few students in a single school but possibly to 20-30 students in a district. Again using the cable interconnection, one teacher or one video-taped program could present the course district-wide.

Supplementary and Enrichment Programs to Home

The entire community could benefit from educational programs available in the home. However, when enrichment programs have to compete with revenue-generating mass appeal programming for limited channel space, the educational programs generally get short shrift. The abundance of channels available on cable means that there is ample channel space available for cultural and educational programming, too.

(7) Municipal Government Access. Local governments (in the major markets) are guaranteed access to at least one specially designated channel on the cable system.[18] Washington, D.C., the ninth largest city in the country, evidences many of the ills of being an urban center: public school problems, traffic congestion, high crime rates, inefficiencies in the delivery of services, problems of governmental coordination, continuing need for various kinds of personnel training.

In the course of this study, a series of twenty interviews were held with administrators, public information officers and other representatives of a number of departments of the D.C. Government.[19] Many interviewees felt that not only would cable be useful in enhancing present services (i.e., traditional public relations and citizen information), but it also could extend the scope of these activities (i.e., in-depth exposure to how institutions operate with provision for citizen feedback could mean a more dynamic and responsive mode of operation). At the same time, many respondents cautioned that citizen feedback and access features would have to be structured with considerable forethought and planning so that expectations would not be unrealistically channeled. For example, it could be potentially disruptive to give the impression that access to the government's ear would mean an immediate solution to all complaints. Some means of making a reasonable response (possibly an ombudsman arrangement) would have to be devised so that people could feel that their voice is heard without getting the impression that the government is being unresponsive.

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[18] Code of Federal Regulations, Title 47, Chapter 1, Part 76 - Cable Television Service, Support G - Cablecasting, Section 76.251(a)(6).

[19] Paquette, Carol, "Summary of D.C. Government Cable Survey," The MITRE Corporation, WP-8564, Washington, D.C., December 1971.

In addition to developing an external interface with the public, some internal organizational changes would probably also be required. For maximum efficiency and cost savings, a central agency or interagency committee would be needed to coordinate governmental users of a cable system in terms of determining timing and duration of programs, giving technical and professional assistance in the preparation and production of programming for external audiences (public service, educational) and scheduling and/or allotting channel time for internal use (conferences, staff meetings). A number of recurring themes were expressed in the course of these discussions. Those which could be addressed through one-way cable services are discussed below.

- Need to find ways to reach inner city. The largest clientele group for governmental services is located in the inner city. This same area is also the most difficult to reach via other media which are largely directed towards the more affluent areas of the city and the suburbs. A compounding factor is the predominant reliance of blacks and low income groups on television as a source of information. The high cost of commercial broadcast time puts it largely out of reach of most agency budgets except for occasional spot "commercials." These brief announcements cannot do the job of informing the public of the range of services available through various agencies. Data on standards of eligibility, where to go for more information, how to apply, and the like also need to be presented in an informative fashion.

Need to create better information and attitudes towards city services as well as get citizen feedback. A better knowledge of how government agencies operate through an in-depth exposure may have a double pay-off in engendering greater public understanding of institutional problems as well as greater public sophistication in dealing with governmental agencies. Some means of getting the citizens more involved in the governmental process is especially needed in Washington whose only elected officials are the members of the school board and a non-voting delegate in the House of Representatives.

Need to provide public service and educational programming. This represents a very broad expanse of possibilities encompassing a full range of governmental activities and including enrichment and traditional educational programming as well as public service information on such topics as nutrition, preventive health, household management, and child care. Vocational training and vocational rehabilitation are other potential uses.

While these needs pertain to some extent in every urban area, they are especially significant in Washington whose officials are all appointed except for the school board. The local political process which provides at least some rough measure of citizen information and feedback does not exist in the District of Columbia. A more common urban problem is the lack of an effective medium through which communities can air local issues. The Sloan Commission Report succinctly illustrates some of the less obvious aspects of this situation:

> "The opportunity for those with issues and grievances to expose them...is of particular significance in the inner cities, and it is there that television is not only the medium of choice, but (along with radio) the only pervasive medium that is available. The dilemma in such areas is exemplified in some of the consequences of the decision, in New York City, to decentralize control of the schools. Dissatisfaction with the operation of the school system is pervasive in New York City, but there has been no way for the community as a whole to examine the roots and the nature of that dissatisfaction, to reach a consensus on the manner in which it can be remedied, and to act on that consensus. In the absence of such a consensus one is likely to find that little emerges other than groups of warring factions, no one of them representative of the community as a whole simply because the community cannot be involved in their deliberations. School board elections attract only a few percent of the voters; the results of the elections can hardly be called representative, and the grievances remain not only unresolved but largely unstated."[20]

The municipal channel could provide, among other services, a forum for community dialogue through cablecast town or neighborhood meetings. Since the design of the Washington Cable System allows for coverage on a Service Area basis, a neat matching of local problems to the administrative hierarchy that can act on them can be achieved

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[20] On the Cable, op. cit., p. 124.

(8) Leased channels. The FCC regulations state that the remainder of the required bandwidth in addition to the designated and broadcast channels shall be made available for leased use. On at least one of these channels part-time users must be given priority.[21] The cable system must establish rules requiring first-come, nondiscriminatory access, prohibiting the presentation of lottery information and obscene or indecent matter, requiring sponsorship identification, and specifying an appropriate rate schedule.[22] The Commission at a later date will issue a proceeding on rate structures.

A number of channels for lease should, if possible, be left unallocated to specific users. There are likely to develop a wide variety of unanticipated uses as the public becomes aware of the possibilities of wideband cable. This potential for growth and experimentation should be maintained by having a margin of spare channels available to a variety of users as the capacity of the system is increased.

There will be many types of users for these channels: private citizens, political candidates, non-profit organizations and clubs, profit organizations who wish to show their own company-oriented or public-oriented programs. The particular appeal of cable for political candidates is its ability to provide localized and geographically defined audiences. It no longer becomes necessary for the candidate to purchase area-wide media coverage when all he really wants to reach is a selected district. The following headings are some further examples of services that might be programmed by various sponsors and presented over leased channels.

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[21] Code of Federal Regulations, Title 47, Chapter 1, Part 76 - Cable Television Service, Subpart G - Cablecasting, Section 76.251(a)(7).

[22] Ibid., Section 76.251(a)(11)(iii).

(9) Instructional programming. In addition to the above index and calendar-type informational services, instructional programming of various types could be cablecast to the community. A common observation of inner city teachers and administrators is that many children are educationally deficient even before they enter school. A televised preschool program utilizing already developed Head Start concepts could help to bridge this gap and could thereby enhance later in-school learning for these youngsters.

Adult education could also be made more readily available to everyone in the community. Inadequate public transportation, especially during non-work hours, prohibits many inner city residents from taking advantage of present adult education classes. In addition, many women with children at home also find it difficult to get out to attend class. High school dropouts, functional illiterates, and others who may be embarrassed by their educational deficiencies could take courses privately and anonymously. Kentucky Educational Television has recently undertaken the design of a televised series to prepare adults for the GED high school equivalency. The Corporation for Public Broadcasting is also researching a similar program.[23]

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[23] ETV Newsletter, Vol. 6, No. 4, February 21, 1972, p. 5.

There is a large community of institutions of higher education in the District of Columbia ranging from full universities offering postgraduate degrees to small one or two-year vocational schools offering certificates. Like many other public and private schools, many of these D. C. institutions are experiencing financial problems and are looking for better ways to utilize available resources.

In response to these problems a number of institutions elsewhere are trying out the "open university" concept. This development involves taking regular courses of study through correspondence work, viewing of television lectures and individual reading in local libraries, often combined with brief work in residence at the university campus.[24] This seems to be an especially appealing approach for Washington schools where a large percentage of the adult working population is already pursuing degrees on a part time basis. In addition, this is an opportunity to provide a low cost college degree to disadvantaged persons who otherwise could not afford the $70.00 or so per credit hour or the time off from work to pursue the traditional degree route of campus residence and course work. For example, State University College in New Paltz, New York, is presently offering a three credit introductory course, Psychology Today, over the area cable systems. The course is offered twice weekly for a twelve week period. While all CATV subscribers may view the course, those wishing regular college credit must register with the university and pay a tuition fee of $58.05.[25] The University of Rhode Island offers a course in American Negro literature on cable. The instructor of this course says, "Cable television allows a variety of people who cannot actually 'attend' school to become familiar with a subject vitally important to them."[26]

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[24] Boyer, E. and Keller, G., "The Big Move to Non-Campus Colleges," Saturday Review, 17 July 1971.

There are many educational needs for specific interest groups within the various Washington communities which have not been addressed by institutionalized education. For example, Washington is the temporary home of many foreign nationals on a diplomatic, educational, employment or tourist basis. Many of these visitors want to learn the English language, to learn about this Capital City--how to get around, how to learn about its history, laws, landmarks, cultural activities, facilities, etc.--or to rapidly learn "survival" skills and useful information about this city and country. Washington also has a large Spanish speaking population. This community needs English language courses as well as other educational courses conducted in Spanish.

Nearly all of the Administrations in the D. C. Department of Human Resources could profitably utilize substantial channel time in providing educational materials to their various constituencies throughout the city. The Vocational Rehabilitation Administration, for one, conducts an extensive training program in conjunction with a number of other D. C. agencies. A listing of their clientele groups illustrates the range of problems that can be at least partially met through an enhanced educational communications capacity: alcoholics, drug addicts, visually impaired, deaf, psychiatric, mentally retarded, public offenders, public assistance recipients, school dropouts, juvenile delinquents, socially deprived, the physically and emotionally disabled and other handicapped.[27] As is frequently the case in special education, the number of trained staff is not sufficient to meet the demands for their services. In addition, there are not only a multitude of types of handicaps, there are many different degrees of impairment which require different types of training. A broadband telecommunications system which can extend the capabilities of the present staff in both time and space (by making instruction available via the home television receiver) could conceivably increase the effectiveness of this agency's operations.

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[25] "College Comes to N. Y. Cable Subscribers," NCTA Bulletin, Vol. 1, No. 1, September 28, 1971, p. 2.

[26] "Lit Course on Cable," NCTA Bulletin, Vol. 11, No. 10, March 7, 1972, p. 3.

The Social Services Administration provides programs in home economics, consumer education, money management, home management, self improvement and grooming to low income families, centers providing day care services and other community agencies and organizations. These programs could be given on a continuing basis and in more depth if they were delivered to the home via the cable. In addition, SSA has responsibility for the foster home program and for some day care centers. General counseling services, training and enrichment materials could be provided on a regular basis to these homes and centers, thereby strengthening and upgrading these programs. One source in the Department of Human Resources indicated that a major problem in the foster parent program is that foster children frequently require special guidance and handling which most lay people are not equipped to give. Although Human Resources is committed to help with these problems, lack of resources and staff limit the amount of one-to-one guidance they can give. While individual cases would still require individualized attention, general guidance and information could be cablecast on a regular basis and would potentially result in fewer "drop-out" foster homes.

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[27] "Services of The Department of Human Resources," D.C. Government, June 1971, unpaged.

The Narcotics Treatment Administration has a big job of informing the public about drugs and their use and misuse. Ex-addicts have had remarkable success in helping to slow down drug abuse through rap sessions at schools and community centers. If this type of programming expanded with information about treatment and rehabilitation programs could be televised in the District, Human Resources personnel feel that a measurable decline in drug traffic, especially among the young, could be effected.

(10) Health Services. There exists a substantial need in the District of Columbia for expanded delivery of health services. Both the infant mortality rate and the tuberculosis rate are higher than the national average. (See Table A-2, Appendix A.) Although telecast programs cannot replace medical attention by a physician, these

problems could be somewhat ameliorated through programming on general nutrition and hygienic practices as well as telecasts directed specifically to prenatal and child care, recognition of disease symptoms, where to go for medical examination or treatment, when to call a doctor.

A recent report on a 1970 monitoring of health information disseminated over broadcast television revealed that health-related content (including commercials) used 7.2% of the typical 130-hour broadcast week. However, only 30% of this health time offered useful information and the remaining 70% of the material was inaccurate or misleading or both. The investigation in this study concluded:

> Television, a most powerful communication medium, has a long way to go to fulfill its public responsibility to educate accurately and effectively about health. A recommendation of this study would be to make more time available to health-oriented persons for the presentation of useful television health information and education in a stimulating format. The time should be at least equal to the inaccurate or misleading health information that amounts to 5 per cent of all television time. The potential of television to inform, instruct and educate should not continue to be wasted and abused, but rather should be used as an integral part of a plan designed to deliver better health care.

The Community Health Services and the Mental Health Administrations both have sizable informational and instructional components in their missions. One of their biggest problems is informing people of what services are available and then, once informed, getting people to utilize these services. The Health Services Administration feels that word-of-mouth throughout a community is their best method of getting people to come to HSA centers once they know about them. If someone in a neighborhood has come to a clinic and received good treatment he will tell his neighbors and more people will come. However, this technique works both ways - if someone has a bad experience this will get around the community, too. It was suggested that in-depth programs showing what happens at treatment centers as well as providing accurate information about various programs could help change this pattern. Even with their all-out campaign against lead poisoning they found that many mothers would not bring their children for tests. Either they did not know what was going to happen or they had more apprehension concerning the immediate drawing of blood for testing than about the more serious, but also more distant, effects of the poisoning.[29]

(11) Special interest programming. The multiplicity of channels on a cable system could foster variety of programming by presenting series of special interest materials on sports, hobbies, travel, gardening, bridge, investments - the list is endless. "Sesame Street," "The Electric Company," and "Zoom," among others, have provided new models for children's programming. Research conducted by Action for Children's Television has shown that 2/3 of all children's programming is of the "chase-adventure" variety.[30] Considering the average TV

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[29] See also On the Cable, op. cit., pp. 102-105.

[30] Forum on "Children and the Mass Media," White House Conference on Children, December 1970.

viewing time of children, this is a considerable waste. More constructive and creative children's programs could make it less so. The Children's Programming Corporation of New York is one organization that has just been formed to create and market such children's programming.[31]

FULL ONE-WAY

The Full One-Way system provides frame-stopped video services in addition to the Limited One-Way services. As mentioned above, many of the conventional services could also be provided in this mode. In addition, Public Information Services could be provided under Limited One-way, but the quantity of information is potentially so great that frame-stopping capability would be the most efficient and useful form of delivery.

(1) Public Information Services. An enormous amount of community information is generated by the municipal government, private and non-profit service agencies and other groups. A public information channel (or channels) could provide a convenient reference source for city residents as well as a means for these groups to reach their target clientele. Some suggested program topics follow.

- Employment Information. Up-to-date job descriptions, locations, accessibility by public transportation, how to apply for jobs including experience required and educational level required, where to apply, and other employment related information.

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[31] ETV Newsletter, Vol. 6/No. 4, February 21, 1972, p. 6.

- Transportation Schedules. Public transportation schedules, fares, and other transit user's information.
- Welfare Information. Names, addresses, phone numbers, hours and services of welfare agencies. Welfare qualification requirements, how to process application, types of aid available.
- Health Information. Location of clinics, index of services provided, cost, health care information (such as disease recognition, prenatal care, infant care, nutrition, general hygiene).
- Legal Information. How to obtain legal counsel, where, fee schedules, what type (civil, criminal), general rights of citizens.
- Guide to Federal and Municipal Agencies. Information on government and municipal agencies and programs--e.g., which agency handles housing code violations, how to contact them, what to expect after contact is made.
- Drug Addiction Rehabilitation Information. Types of programs, eligibility standards, locations, what to expect, what is expected of applicants.
- D. C. Events. Announcements of local events such as the troop meeting of the local Boy Scouts, D. C. Recreation Department programs, Summer in the Parks, street theater, special exhibits at the Smithsonian and other local museums and galleries, church bazaars, public meetings.

Using a conventional cable system, this information could be presented on one or more channels in a prescheduled format, i.e., welfare information will be presented every day at 10:00 a.m., 3:00 p.m. and 9:30 p.m. By the addition of a frame-stopping device and a subchannel tuner to the home television receiver and a mini-computer at the headend, these materials could be available on demand as has been demonstrated by MITRE using the Reston, Virginia, cable system.[32]

The design of the WCS would allow all of this information to be tailored to and delivered on an individual Service Area basis. For example, locations of clinics and other service agencies could be identified within their own Service Area rather than being included in a complete list of city-wide locations. The resident of Southeast is not likely to be interested in where clinics are located in Northwest unless there is none closer to him. In addition, the types of information of interest would vary somewhat across the city. Welfare information, for example, would be more relevant to the residents in S/As 5, 6 and 7 than those in S/A 8.

(2) Subscription Channel for Professionals. One of the problems of a highly technological society such as ours is the "knowledge explosion." How to efficiently disseminate all the information constantly generated to those interested in or needing it, has become a paramount question especially in such active fields as medicine and

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[32] Volk, John, "The Reston, Virginia, Test of The MITRE Corporation's Interactive Television System." The MITRE Corporation, MTP-352, Washington, D.C., May 1971.

law. Washington, as most urban areas, has a large number of medical, nursing, and medical technician schools, practicing medical personnel, hospitals, law schools, law firms, trade associations, and the like, all of whom have a great need to keep abreast of developments in their respective fields.

For example, lawyers interested in recent court decisions and their impact on a particular area of the law can tune in for a brief synopsis of these developments. Doctors may view information on new drugs, new operational techniques, or a rare disease may be seen by many doctors and medical students who might otherwise never view such a case until they have to treat it. The National Medical Audiovisual Center of the Public Health Service and the Roche Laboratories are two sources of materials which are presently available.

(3) Pay TV. The addition of an address encoder-decoder device under Full One-Way would permit programs to be shown on a pay TV basis. First-run movies and championship sporting events could be distributed to individual homes willing to pay an additional fee for the program.

TWO-WAY SERVICES

Interactive or two-way systems can provide an important new dimension to cablecasting. Such systems allow the viewer to send messages back to the cable headend. The viewer's messages can be responses to questions in which he chooses between a number of alternatives by pushing a button to identify his choice (e.g., polling) or his message could be a request for a service which he sends by typing it on a keyboard at his home terminal. Alternatively, the message could be originated by a variety of automatic devices located in his home or business establishment. Two-way capability is expected to have widespread impact on future cable programming and system design. However, it is expected that this extra capability will be accompanied by a 100% increase in system costs and an 86% increase in subscriber fees over the conventional one-way systems, when the capital costs include the cost of subscriber terminals. (See Section VI-Financial Analyses.) The services that would be provided by the WCS would be incremental in nature, i.e., all two-way services (both Subscriber Response and Electronic Information-Handling (EIH) would be in addition to the one-way services. An EIH system, then, would provide all the services listed under One Way and Subscriber Response as well as the services that are unique to EIH. Similar to the one-way case, leased channels would also be available with two-way capability.

Subscriber-Response

A Subscriber Response capability as defined in this report, is one in which the subscriber-initiated message is limited in length. This message is primarily a coded request, status or signaling message. The message from the headend will be either a polling sequence or a burst of alphanumeric information. Some of the interesting interactive services that can be provided through this capability are discussed below.

(1) Interactive Educational Programs. In the future educational courses of all types could be offered via a subscriber response system.

In this format, the system would provide immediate audience feedback to a teacher of any subject, and any grade level from pre-school through university level, to indicate whether students are comprehending the subject under discussion. Questions from the students could be screened by a computer, in real-time, and consensus questions presented to the teacher as the session proceeds.

(2) Interactive Entertainment. A two-way system makes possible a wide variety of new interactive entertainment programs in which the development of the programs is dependent upon audience responses. This has broad application to games, dramatic shows, panel discussions and a variety of other new types of TV entertainment programs. For instance, children's programs could contain interactive elements in which the viewer is asked to respond to questions and situations. The responses of all viewers or selected viewers could then be shown immediately and used to provide direction to the remainder of the program. Such approaches were used with much success in some of the Expo 67 exhibits. Adult drama, comedy and other types of shows could also be designed in the same fashion.

Political programs and talk shows could use subscriber response systems to provide audience participation through responding to questions and expressing opinions. In addition, various types of interactive participatory, many-player game shows might be developed in the format of "Concentration," "To Tell the Truth," and "What's My Line."

(3) Preference Polling. In essence, polling (i.e., a procedure in which a viewer chooses from one of several alternatives by pressing appropriate buttons on his home terminal keyboard) provides a feedback information link between TV viewers and a large variety of opinion pollers. Topics might include TV programming, politics, products, a lecture or discussion that has just been aired, a movie, or an endless variety of other subjects. (Instant Nielson surveys could be provided much more cheaply and frequently.) This capability can be readily supplied by a two-way interactive system and is likely to be quite popular once it is developed and tested.

In the early stages of the WCS it will be important to develop an audience voting capability within the system as an aid in optimizing program content and types. The cable system operator would be able to obtain opinions from viewers as to which programs they like or dislike, as well as what new programs they would like to have presented. These data can then be tabulated and analyzed for use in system program planning.

Government agencies as well as political office holders could use this type of vote tabulating service to assess responses to various questions and issues that are of public interest. Public opinion polling could be conducted much more frequently and extensively.

Similarly, manufacturers and distributors of goods and services could use video channels to display products and services to subscribers and to conduct market surveys.

(4) Catalog Shopping. General shopping services could be provided with a subscriber response system. Businesses and stores could display and demonstrate products and services for sale, or conduct auctions, by using either video catalogs or video cameras and displays. For this type of shopping service different times of day might be set aside for displays of various types of goods and services. A subscriber could observe these programs and order goods or services through the use of his keyboard response channel. A record of the transaction would be performed automatically by a computer at a central location. Order verification could be provided via strip printers built into the subscriber terminal which would instantaneously display his typed request. The types of products that would be merchandised could vary from area to area. Using the selectivity that cable provides, the home shopping merchant can vary his offerings to coincide with the buying power and purchasing profile of a particular area.

(5) Alarm Communications. Various types of surveillance alarm services, such as burglar alarms and fire alarms, could be provided for homes and businesses. Outputs of these surveillance devices could be sent automatically, via a subscriber s terminal, to the appropriate public safety or maintenance center for action. Each transmission would contain the subscriber's address. Calibration devices and maintenance routines would be provided to permit periodic testing of the surveillance devices, thereby reducing false alarms.

(6) Utility and maintenance services. A number of examples of utility and maintenance services that could be provided by a Subscriber Response telecasting net are discussed below. If there is a terminal in the home being used for a variety of cable services, the add-on cost of these services will be quite low, making a great many of these applications available to the average subscriber.

Maintenance Services - The basic polling feature of the subscriber response system could be used to check the entire cable distribution system and all subscriber response terminals at frequent intervals. Signal levels of amplifiers at multiple locations in the distribution system, as well as at all terminals, could be monitored from a central location to diagnose operational problems in the system. These procedures could be used to locate specific amplifiers or terminals that require either preventive or emergency maintenance and would be used to keep these components of the system in satisfactory working condition and to minimize service outages. Similarly, the cable system could be used to make maintenance checks of a variety of equipments. This feature could prove quite attractive to a company in preventing excessive downtime losses.

Meter Reading and Automatic Billing - Several types of automatic meters for electricity, gas, and water are now available which could be adapted for use with the response terminals of a two-way cable system.[33] These meters could be interrogated as often as desired by a central computer. Each meter response would carry with it the address of the subscriber. The central computer would store and tabulate the data received and automatically calculate monthly billings. These data and billings could be transmitted to the utility companies for their action. Economically, the use of cable systems for these meter reading functions may be quite attractive, particularly if high system penetration is achieved by other services and a universal home terminal can be shared by the utility functions and various other types of service functions described in this section.[34]

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[33] "A Black Box to Replace the Meter Reader," Business Week, February 12, 1972, pp. 70-71. This article cites developments by AT&T, Metrolab, Westinghouse and Neptune Meter Co.

Selective Load Control and Load Monitoring - Another important potential application of two-way, interactive cable systems is for selective load control of devices in homes, offices, business establishments, and schools.[35] For instance, for several years a number of power companies throughout the nation have been reducing their peak load requirements by offering special rates to customers who are willing to use time switches to disconnect the lower element of two-element electric hot water heaters during predicted peak load periods. However, with the advent of widespread use of air conditioning, washing machines, dryers, and other home appliances, the characteristics of daily power loads have been changing significantly over the past several years and are hard to predict.

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[34] Eldridge, F. R., "System for Automatic Reading of Utility Meters," The MITRE Corporation, M72-7, September 1971.

[35] Eldridge, F. R., "The Use of Cablecasting Systems for Control of Electric Power Grids," The MITRE Corporation, WP-7584, May 1971.

Detroit Edison, to overcome this problem, has implemented a radio system for rapid, direct control of hot water heater switches during peak periods. As indicated in Section V the cost savings in power generation and transmission facilities can be very significant with this type of control. A similar system could be incorporated in a two-way cable system, using selected terminals for turning off less critical electrical devices, such as hot water heaters, electric dryers, washing machines, and air conditioners, during overload periods, while leaving on more critical devices such as iron lungs, elevators, subways, and electric lights. In addition, information on the operational status of these devices could be sent to a central computer for monitoring and control purposes. After a power load-shedding operation, the same system could also be used to turn on electric devices, in a selective and time distributed manner, to avoid transients and resulting system overloads. The system could also be used to monitor power system loads during normal operations for purposes of system maintenance, design and planning.

Leak Detection - Homeowners, utilities and insurance companies could benefit from real-time safety control over a number of systems in the home. Technical systems are available which can detect gas leaks, shut off the gas supply to specific appliances, and signal an alarm to both the subscriber and the gas company. The costs of these devices is high but they have the potential to reduce risks due to explosion. Substantial insurance savings may result. Similarly, oil burner operating problems could be detected, the supply of oil shut off and an alarm set off to alert the residents and the maintenance company to the problem. This capability may also be extended from the home to industry for a variety of special safety hazard applications.

Electronic Information-Handling

Electronic Information Handling provides the capability for large amounts of information to be transmitted in a variety of formats (i.e., alphanumeric or pictorial) at the subscriber's request. It also allows active interaction with a computer for individualized services such as personal record keeping and updating.[36] (A full description of EIH is contained in Appendix B, Technical Implications of Programming and Services.)

One-way Electronic Information Handling Interactive EIH services can be provided over a one-way system by the addition of a frame-stopping device and subchannel tuner to the home television receiver and a mini-computer at the head end. This type of delivery system has been demonstrated by MITRE using the Reston, Virginia cable system with a telephone line for the return link.[37] (One-way EIH capabilities are described under Full One-Way Services in Appendix B.) Two-way EIH services are described below.

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[36] See Stetten, Kenneth J., "Interactive Television Software for Cable Television Application," (The MITRE Corporation, MTP-354, June 1971) for an outline of possible services.

[37] Mason, W. and Polk, S., "Revolutionizing Home Communications," presented at '72 IEEE INTERCON, March 20, 1972.

Volk, John, "The Reston, Virginia Test of The MITRE Corporation's Interactive Television System." The MITRE Corporation, MTP-352, May 1971.

Stetten, Kenneth, "TICCIT: A Delivery System Designed for Mass Utilization." The MITRE Corporation, M71-56, October 1971.

(1) Computer-aided Instruction. The addition of a computer at the headend permits individualized computer-aided instructions (CAI) either in the home or school. The advantage of this system is that it allows for individual differences in the degree of difficulty of the subject matter, the level of proficiency of the student and the time needed for him to cover the subject. Each student's performance can be analyzed on an individual basis and his scores and test marks recorded and reviewed at any future time to indicate the trends in his learning. In addition, a calculation service as well as a data storage and retrieval service could be used to assist the student with either his homework or in his development of special reports on various subjects. In Overland Park, Kansas, for instance, a cable system is providing interactive instruction to homebound students through both voice and video response from the student.[38]

Interactive educational programming is technically possible right now, and the economic feasibility is improving. However, as discussed under one-way educational services, new institutional arrangements and even some basic concepts about what a school system is may have to be developed. Much courseware development will also be needed.

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[38] Katz, Dr. Harold, Technical Panel on "Two-Way Operation--Boom or Bust," NCTA Annual Convention, July 8, 1971.

(2) Interactive entertainment. EIH has the capability to provide more individualized interaction than the Subscriber Response Services described above. With EIH, in addition to the types of programs described under SRS, a number of few-player or one player games might be provided on a two-way system, including such games as bingo, bridge, tic-tac-toe, checkers, chess. Chess or bridge problems could be presented for a viewer to solve with comments on the various key moves that he would make in response to the game problem.

(3) Social services. Many of the services discussed above under Public Information Services, Instructional Programming and Health Services, could also be provided in an interactive mode. This increase in capability would allow more individual flexibility, both in terms of what level of information is retrieved and when it can be retrieved. Some of the types of services which could be enhanced by two-way capability are listed below:

- Employment information
- Transportation
- Welfare information
- Health information
- Legal information
- Guide to Federal and Municipal agencies
- Drug Addiction Rehabilitation information
- D. C. Events.

In addition, an ombudsman service could be implemented interactively by allowing a subscriber to enter specific questions and criticism about community affairs or complaints through his terminal and to receive either an alphanumeric or video response. This would be the cable equivalent of the "Hot Line" service conducted by many newspapers and radio stations.

Vocational counseling could be implemented using guidance counselors, assisted by a computer to respond to subscriber initiated requests for vocational information. The viability of this service would depend on the availability of suitable sponsors and probably would require a sophisticated semiautomated or automated data base.

(4) Video library. Cameras and other appropriate origination facilities could be set up in libraries or museums, Federal and Municipal offices, and other public reference sources to be used in responding to specific subscriber's inquiries for information, for which a video response would be useful. This system could be used to transmit pictures, maps, diagrams, pages of books, and other forms of data. The information could be displayed immediately on the subscriber's television set or recorded either on tape or with facsimile for later inspection and study.

(5) Individualized shopping and reservation. Individualized shopping services could be provided if current inventories of businesses and stores were available in a central computer memory. Under these circumstances, the subscriber could use his keyboard to describe a

particular item that he wishes to buy. The computer could then search the inventory records and tell the subscriber which businesses or stores have that particular type of item in stock. The prospective buyer could then go to see the item before deciding to buy it, or he could order it immediately from one of the available sources through the use of his home terminal keyboard.

Reservation services could be provided by similar procedures. Each subscriber would be able to call up data from a number of service category fields by entering a request for the category desired. He could request schedules, diagrams showing locations of available seating, etc. Using this information he would, through the use of his keyboard, make his own reservations for air travel, sporting events, restaurants, theaters. A record of the reservation and automatic billing would be provided by a central computer.

(6) Banking and credit services. For each subscriber, banking, income tax, family budgets and other records could be maintained and retrieved on demand. The value of stock portfolios could be kept-to-date, and other types of banking and credit services could be performed by the system. Security for these types of services would be maintained through the use of coding devices, scramblers, distributed transmission, etc. In conjunction with these banking and credit services, a calculation service, of the type being demonstrated at Reston, Virginia,[39]

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[39] Volk, John, op. cit.

could also be provided for tabulating checking accounts, calculating income taxes, and other services.

SPECIAL SERVICES

Special services are similar in nature to the point-to-point services, discussed below, except that they would serve the larger geographic area covered by the telecasting net. These services require two-way transmission to provide telemetry and data communications services. Some specific examples of various types of Special Services follow.

(1) Traffic control. Due to the fact that the cable will be passing every street corner in the District, it will offer a unique opportunity to establish a traffic control system. Traffic counters could be directly tied into a computerized traffic light control center via the cable and timing of lights could be automatically adjusted to promote traffic flow. The Department of Highways and Traffic in D.C. is currently conducting a traffic control experiment utilizing phone lines as the communications link.[40] Initial estimates indicate that the use of cable could as much as halve the communications costs for a city-wide system.

(2) Mobile radio communications and automatic vehicle monitoring. The increasing demand for mobile radio for dispatching and mobile communications for police, fire, taxis and other fleet operations has

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[40] Scott, J.E., "Urban Traffic Control Laboratory in the District of Columbia," National Telemetry Conference, 171 Record.

reached a critical point in major urban areas. Spectrum availability is limited while the number of users continues to increase. One of the most effective means of offering mobile radio service to many more users is the use of cellular areas of limited radio coverage and the multiple reuse of radio frequencies within a metropolitan area.[41] Each cell would contain a small base station to communicate with vehicles within that cell. These base stations could be interconnected by cable to a central administrative center which would coordinate communications from cell to cell.

An automatic vehicle monitoring (AVM) system could be associated with a cellular communications system and use the same components. An AVM system monitors the position of moving vehicles and can enhance the operations of mass transit, police, and other fleet operations.[42]

(3) General-purpose digital communications. The tremendous bandwidth of cable provides an opportunity for distribution of digital information as well as for conventional TV signals. Much of today's commercial/industrial information exchange makes use of digital communications, and there is a growing need for interaction of computer data bases. A general-purpose digital system would provide a two-way digital communications link for any two subscribers, not limiting them

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[41] Eldridge, F. R., "Future Land-Mobile Communications," Research Analysis Corporation, RAC-P-48, January 1969.

[42] Gould, A. V., "Automatic Vehicle Monitoring," EASCON 1970.

to any particular code, format or message length. This service could be provided utilizing the basic components of the Subscriber Response system described above.

The MITRE Corporation has developed a technique to overlay digital communications on a two-way cable network that will not interfere with concurrent distribution of TV and FM broadcast signals.[43]

(4) Local distribution of special common carrier services. The FCC ruled on May 26, 1971, that special common carriers may offer point-to-point services using microwave interconnecting lines in competition with existing common carriers. These carriers offer services such as computer data communications and private lines services for telephone, telegraph, and data messages for large business and noncommercial users. The WCS could be used as the local distribution system between the special common carrier terminals and the terminals of their individual customers. Appreciable cost savings are made possible by sharing the capacity of either the telecasting net or the point-to-point nets.

FULL TWO-WAY SERVICES

Full two-way services are here defined as those that require wide bandwidth on the response link that is capable of video or high speed data as compared to the narrow bandwidth return utilized for the two-way services discussed previously. Connections would be from subscriber to headend and return.

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[43] __________________, "Digital Cable Communications," The MITRE Corporation, M71-113, January 1972.

The bulk of subscriber-to-subscriber two-way services would be provided through the utilization of, or tie into, a point-to-point net in the WCS, as described in the following section. However, for a very limited number of subscribers, the telecasting net could also be used for these purposes when a larger area of coverage (number of receiving subscribers) was desired than that provided by the point-to-point network. For instance, closed circuit television (CCTV) channels, facsimile channels, and various other types of home and business wideband communications could be provided using switching at the headend or sub-headends to make the proper channel connections for the service.

Since it is presently envisioned that only one of the four available upstream channels per service area will be used for computer polling in the limited two-way mode of operation, two to three upstream channels could eventually be used to transmit program originations upstream in the telecast network. Thus 18 to 27 (2 to 3 channels for nine Service Areas) subscriber-originated or other special program originations could be transmitted, simultaneously, back to the system's headends for distribution over the telecasting network.[44]

POINT-TO-POINT SERVICES

Our analysis has indicated that a single channel each for school and municipal use is extremely inadequate. Consequently, in addition to the telecasting net, additional point-to-point cable channels would be provided by the WCS to meet community needs. Point-to-point networks would allow certain institutions to be interconnected on a full two-way basis. Special users would be the Municipal and Federal governments, universities, and business organizations. As noted in Section IV, each special point-to-point network would have the capacity for at least 14 6 MHz two-way channels. Our studies and discussions have indicated that one of these networks could be entirely utilized for municipal services. The other point-to-point requirements have been estimated based on the idea that a variety of institutional benefits would accrue to certain types of companies or public agencies with the availability of a wideband two-way, interactive point-to-point net. In addition, privacy of communications could be provided. The following sections describe the preliminary concepts for these four special purpose point-to-point networks.

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[44] For some problems with upstream video transmission, see Appendix B, the subsection entitled, "Distribution for Subscriber Response Services".

(1) Municipal Services

Municipal Government - The discrete point-to-point cable system could provide essentially a dedicated system connecting all municipal departments allowing for data exchange as well as other communication functions. The utilization of this capability could enhance governmental coordination by enabling the mayor and/or council to confer with any or all department administrators without setting up formal meetings and having everyone come to some central location. The fact that cable would provide both visual and audio communications as well as data information transfer at an economical rate makes this medium more attractive for remote conferences than other available technologies.

As mentioned above, a survey was conducted of various governmental agencies to determine what their uses for wideband communications might be. Two requirements--for better internal communications and in-service training--could be addressed through a point-to-point network.

- Need for better communications within governmental departments. The capability for direct face-to-face communications between agency or department heads and their staffs without submitting to the filters of the printed page or the organizational hierarchy or the office grapevine would provide for more effective communications than presently available. Time could be saved by being able to hold staff meetings remotely with everyone staying at their own location rather than traveling to some central spot. In addition, everyone could sit in on the meeting without the problem of finding a sufficiently large auditorium. Getting the word first hand with provision for questions and discussion could enhance any agency's operating efficiency and employee morale.
- Need for flexible in-service training. Practically every government agency conducts some degree of employee orientation

and in-service training.[45] Both the large size and the decentralization of many agencies makes it difficult to coordinate these programs in an efficient manner. Considerable time and dollars are spent in people traveling somewhere to make a class. In addition, departments like police and fire have a continuing need for up-to-date training while their personnel work various shifts. A municipal cable network tying together all governmental sites could put an end to much personnel travel and allow a more efficient utilization of training staff. In addition, more personnel time as well as budget dollars could actually be devoted to training since travel time and expenses could be significantly reduced.

In addition to these general governmentwide applications, a number of more specific uses was outlined for the Criminal Justice System (police, courts, corrections) which would be one of the major governmental users. A summary of these various applications follows.

. Prosecutors could use cable TV with facsimile capability for rapid transmission of court orders and other records where a hard copy record is required.

. Cable could be used in training of homicide squad by enabling them to view autopsies and thereby learning about pertinent medical analysis which will give them a better idea for reconstructing the crime and what to look for in investigation.

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[45] Sunnyvale, California, Cablevision has provided its production facilities to the city government for the creation of a video-taped introduction and orientation program for new employees. The tape will be shown on the city's closed circuit system. NCTA Bulletin, Vol. 11, No. 4, Jan. 25, 1972, p. 3.

- Cable could give both law offices and law students better access to courtrooms - important to consider right now because plans are being drawn for new court buildings and cameras and other hardware could be included inconspicuously if included in initial plans and construction.
- Coverage of Decision Days at Supreme Court would be a service which could be networked to major law firms all over the country and for which they would be willing to pay a substantial price.
- Cable could be used for basic education in correctional institutions - great need for this, with insufficient funds to really meet it.
- Televised lineups for offender identification (would possibly require color capability) would be very useful. Present procedure is to have detectives, victims, witnesses come down to Headquarters to view lineups. Could have lineups televised to precincts on private circuit on a regular basis and provide admission pass to those with valid access. Could also present photos of known offenders.

Police officials maintain that there is a criminal hard core of about 500 in D. C. area that is responsible for 85% of the crime; many are prosecuted on lesser charges or for fewer offenses because of identification problem. Criminals can do visual things like add beards, different attire, change hair styles, etc. that can not be done now. This service also would be useful for possible networking to other major cities - to catch the mobile criminal, a growing category.

- Cable hook-ups could be used to provide expert witness testimony without wasting their time. Psychiatrists and chemists are particularly pressed and are most needed to testify.[46]
- Cable arrangement between lawyers and courthouse with tie-in to computerized calendar could save much wasted time. Present system requires two lawyers plus defendant and plaintiff (in civil suits) to spend many hours just waiting for a courtroom.
- Cable might be used in organized crime and drug prosecution where identification is particularly difficult and where operatives generally only know their contacts and none of the rest of the organization. With VTR and cable interconnections it may be possible to put together the pieces, and it would be worth considerable expense to do it.
- Cable could also be used for legal education - problem of a profession with no clinic. It would be extremely useful to allow students to view every kind of legal proceeding from real

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[46] In a recent civil case in Ohio, the entire evidentiary proceeding was presented via video tape, with only opening arguments and summations presented live by the attorneys. The judge and attorneys did not need to remain while the jury viewed the tape, and the trial took only one day in contrast to an average of 1½ days for similar cases heard in the regular fashion. Time, December 27, 1971.

estate closings, bank loan and credit rating procedures, administrative tribunals through the capital crime level. They would be much better prepared to practice law and the quality of the legal system would be greatly improved.

- Cable could be used for stolen auto retrieval by showing photos of cars.
- Cable could also be used for viewing of high crime locations, both for crime prevention and for urban planning use, whereby some physical alteration of the location may be useful in lowering its crime potential.
- Cable network could be of considerable usefulness in facilitating coordination among the agencies of the criminal justice system and other governmental agencies. The Courts, Corrections, Police, Board of Parole, Office of Criminal Justice Plans and Analysis, Narcotics Treatment Administration, Human Resources, Social Services and Vocational Rehabilitation, all get involved in the processing and servicing of prison populations and their families.

Another major governmental user would be the D. C. Public School System. Compared with other major U.S. cities, Washington, D. C. has an average pupil-teacher ratio,[47] a high annual expenditure per pupil, and high average annual salaries for both teachers and administrators.

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[47] Elementary level - 28:1; secondary level 26:1 (FY 1972). Data supplied by D. C. Public Schools.

The school budget has steadily increased over the last decade while reading and math scores have declined. Currently, there is a reluctance on the part of the Congress and the Mayor's Office to continue increasing the school budget. It is felt that more effective utilization of current resources must be made and improved teaching methods must be found. Instructional television has been suggested as one feasible means of helping to meet these objectives.

Many cable systems around the country are wiring school systems without charge and providing trained personnel to help start a comprehensive instructional television program.[48] This concept of a wired school system would provide increased use of resources at a lower cost for the District system. The D. C. School System is not unaware of the possibilities afforded by a telecommunications cable system. In 1969, the District schools contracted with a consulting firm to investigate factors and approaches to be considered in planning and implementing a full-scale instructional TV system. The resulting report recommended the implementation of a number of pilot TV projects by the school system using the ITFS band.[49]

However, the Chairman of the Subcommittee on "Study of Feasibility of Instructional Television," in testimony before the City Council, requested that the option of using CATV be left open.[50] When cable becomes available in Washington, a point-to-point system interconnecting the public schools would provide the capability for a range of ITV applications already of interest to the school system as well as providing a basis for broader experimentation and development of television as a primary educational tool.

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[48] Burell, Dr. Robert J., "CATV Local Origination and the Local Schools," TV Communications, December 11, 1969.

[49] Grabowski and Associates, "A Report on Factors and Approaches to be Considered in Planning and Preparing for Television Systems to Serve the Public Schools of the District of Columbia," Washington, D.C., 1970.

A third major governmental user would be the public medical community. In addition to these services for individuals via the telecast system, a discrete cable network can provide services to the medical community. Interconnections can be made between hospitals and clinics, making medical staff more widely available and perhaps allowing the operation of neighborhood clinics by paramedical personnel.

Cable could also provide improved medical services to individual practitioners through programs such as The Automated Physician's Assistant program currently funded on an experimental basis by HEW.[51] In addition to many of the above services the Sloan Commission on Cable Communications has identified other possibilities such as training of medical personnel and continuing education for practicing physicians.[52] By its nature, much of medical knowledge depends on visual communications and cannot be readily transferred by other means. Central processing of medical records is another possibility which could relieve some of the administrative burden on medical staffs.

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[50] Greene, J. Weldon, op. cit.

[51] Washington Post, July 11, 1971.

[52] Konrad Kalba, "Communicable Medicine: Cable Television and Health Services," Sloan Commission on Cable Communications, May 1971.

(2) Federal Government

While the offices of the Federal Government are located predominantly in Service Area 9, many are also dispersed throughout the entire metropolitan area. In addition, there are many functional communities of interest that cross departmental lines. A discrete cable system could provide broadband communications links between these various agencies and offices for video and digital data communications. Employee orientation and training could be provided over this system. Some departments already sponsor special courses but location or scheduling time prevent many persons from enrolling. Through the use of cable these courses could be made available on a decentralized basis and possibly at various times so that maximum enrollment could be achieved. Many federal agencies have a need for substantial data transfer capacities which could also be provided by the cable system.

(3) Universities and Colleges

A telecommunications cable is needed to connect the six universities and the 17 colleges in the District of Columbia. The major institutions are Catholic, Howard, Georgetown, and George Washington Universities and the Federal City College. The use of cable would tend to facilitate coordination, the sharing of specialized teachers, and the development of a library of videotapes of teaching materials. The proposed services are listed as follows:[53]

- Instructor sharing. Any instructor now located within one institution could be made available to any or all the others. This would greatly expand choice of courses.
- Instructional extension service. Many would continue their academic work if doing it led to a minimum of inconvenience (i.e., without loss of travel time). It is suggested that the Civil Service Commission might react positively to such a consortium-based service.
- Special courses for black inner city residents of the District of Columbia.

A telecommunications cable system is an ideal medium through which to develop these useful services from the universities and colleges.

(4) Commercial and Business Interests

Commercial establishments can utilize the cable for training purposes as well as for other services. Central credit checking and other banking services for many businesses could be provided, as well as other file keeping and record checking functions. These services, however, would necessitate the capability of insuring the privacy of the communications and the security of the data banks at a reasonable cost.

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[53] Berkman, Dave, "A Proposal for a Consortium - Sponsored Inter-Campus and Extension Instructional Television Service, American University, 1970.

The business community has established many faceted teletype data communications networks between offices, warehouses, and manufacturing facilities and use services of leased lines or channels of present common systems. The pervasive presence of the cable with a limited two-way service could provide to such subscribers a means to augment present networks or establish new networks. In alleviating the load of teletype traffic presently being carried by the common carriers and extending such services throughout the community, provisions must be made to effect digital traffic interchange between the cable and the common carrier systems. In conjunction with this interchange, the Digital Cable Communications system being demonstrated by MITRE would pertain.[54]

HUD regulations requiring the installation of electronic alarm systems by business places seeking eligibility for Federal crime insurance became effective on August 1, 1971.[55] The Washington Cable System could provide the necessary communications link connecting the alarm locations to a 24-hour guard headquarters as well as provide for system operation and effectiveness checks.

A WORD OF CAUTION

In summarizing this section on services we turn again to the Sloan Report for an important caveat, "There is no guarantee that the extra channels cable can provide for public services will ever command audiences sufficient to make the enterprise worth the investment of scarce resources."[56] The programming needed to provide a package of a number of the services described above requires not only a large investment in dollars, but also a long lead time. One source estimates that the development, production and validation of four junior college-level CAI courses (65 hours each) runs about $1,350,000 and would utilize twenty staff for two years. The new children's show, "Zoom," has a budget of $325,000 from the Corporation for Public Broadcasting for 13 half-hour shows, or an average of $25,000 per program.[57] From MITRE's experience with frame-stopping services has come an estimate of one to four hours to prepare a single frame of information. At present the number of commercial suppliers of programmed educational materials suitable for cable use is not large,[58] but increased demand for these materials will no doubt increase the number of suppliers.

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[54] "Digital Cable Communications," The MITRE Corporation, M71-113, January 1972.

[55] Federal Register, 1 July 1971.

Another factor not so amenable to market place influence is the present institutionalized structure through which the services outlined above are presently provided. This aspect has been alluded to in the discussion on educational uses. It should be pointed out that the same situation pertains with all other potential cable users. A basic reorientation to providing services to subscribers in their homes rather than having them come to a service location is needed.

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[56] On the Cable, op. cit., p. 111.

[57] ETV Newsletter, January 10, 1972.

[58] One industry source estimates about 150 companies in all with about 25-30 larger companies dominating the market. Among those recognized leaders are Prentice-Hall, Encyclopedia Britannica, 3M Company and Guidance Associates (Pleasantville, N. Y.).

For example, government agencies need to estimate their potential channel needs now in order to provide some guidance to the City Council on channel allotments that should be included in the franchise ordinance. Similarly, construction of at least the municipal point-to-point network should be made a condition of the franchise with the stipulation that the operator can use it for other purposes if the Municipal government does not take up its option. While the operator should provide the network, the government should pay for its usage, just as they now pay for other communications facilities. Agencies should also begin developing plans for integrating cable into their operations with due consideration being given to how operations can best be re-structured. If greater citizen feedback and access are promoted, some means of public interface and interaction will have to be developed. For maximum efficiency and cost savings, a central agency or inter-agency committee would be needed to coordinate governmental uses in terms of scheduling, providing for technical and professional assistance, preparation and production of programming, and interfacing with the cable operator.

Generally speaking, a lot of experimentation will be needed, not only to more fully develop the hardware configurations but also to determine what is or is not feasible to provide. One study has already identified some of the distinguishing characteristics between a local origination effort that succeeded and one that failed.[59] Some of the factors identified included such intangibles as a sense of community spirit and identity and the significance of an enthusiastic and dedicated leader, as well as the more measurable effects of lack of financial resources and cultural diversity. It seems obvious that much of the speculation on what cable will ultimately be able to provide will never be verified or discounted until these applications have been tried out, both in demonstration projects and in full scale experiments.

SUMMARY

In brief, this section has provided a discussion of the significance of television as the most pervasive information and communication medium in our society. Cable television has the potential of providing a great expansion of television services through an economy of abundance: many channels and thereby cheaper costs and increased access. In addition, since channel scarcity is no longer a hindrance, programming can be developed for particular audiences instead of the mass appeal programming dictated by the economies of broadcast TV. In addition, many non broadcast-type services can also be provided. A broad sampling of potential programs and services was addressed to illustrate the range of future applications of broadband cable communications. Finally, a few cautionary words were given on some of the uncertainties involved in bringing cable's potential to fruition. A great deal of effort and planning by many different groups will be necessary if the wired city concept is ever to get off the drawing boards and into the streets.

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[59] N. Feldman, "Cable Television, Opportunities and Problems in Local Program Origination." The RAND Corporation, R-570-FF, September 1970.

SECTION IV

A SYSTEM DESIGN[1]

Section III identifies some of the programming and services that can be provided on cable systems to support the needs of urban areas. This section presents a technical description of the evolutionary development of a cable system designed to provide the types of programming and services outlined in Section III.

The hardware and software options that were considered in developing the design of this system are discussed in Appendix B. Section VIII, Demonstrations, discusses demonstrations of advanced capabilities such as Automatic Vehicle Monitoring, and Traffic Control. The capabilities would be interwoven into the WCS as their concepts are integrated into cable communication. The Washington Cable System (WCS) described here is not, of course, offered as a solution to all problems of the city; however, it is expected that it will definitely support a number of different types of efforts that are being made to respond to the many demands and needs of the city. The WCS presented here has also been designed to provide the flexibility needed to adapt to new approaches for meeting the changing needs of the city.

In general, two distinct types of system configurations are used as indicated in the previous section. The first of these is a telecasting net designed to serve the general public, and the second, a point-to-point net to serve various institutions of the city. The telecasting net would initially be a one-way system that would evolve into a two-way system over a period of five years. The point-to-point would be full two-way throughout from the initiation of services on the system. Figure IV-1 summarizes the two types of nets provided.

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[1] Portions of this section dealing with conventional cable television are based on the Jansky and Bailey Report, Engineering Report on the Development of a Television System for Washington, D. C.

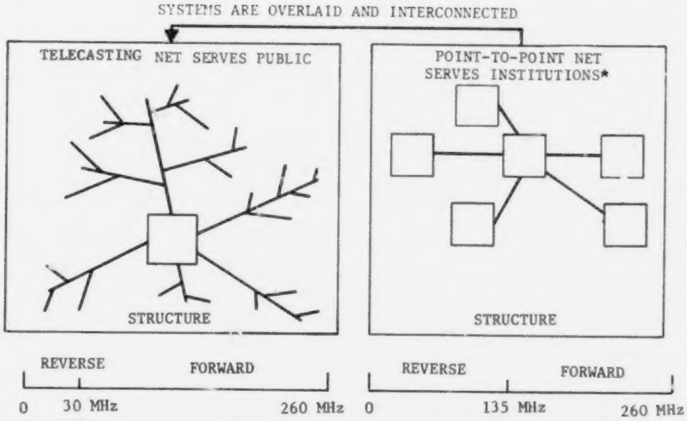
THE TELECASTING NET

Master Headend and Subheadends

In order to provide flexibility of operations and to enhance signal quality to even the most distant subscriber, nine subsystems, one in each D. C. Service Area, have been projected for the WCS system. All of the nine subsystems will, in this plan, be under the same management. The subheadends will be central distribution hubs for programs and services fed over the cable to subscribers in their associated Service Area. Each subheadend will include a studio suitable for modest production work of local neighborhood or community interest.

These studios will be augmented by mobile studios for local program origination. The WCS will have one major mobile color studio with two color cameras and two other color mobile studios with one color camera each for the District. These units include vans, cameras, tape recorders, sync generators, and other such equipment.

Also available at each subheadend, for distribution via the cable, will be "local" off-the-air signals obtained through the use of a nearby array of VHF and UHF antennas. As described later, some subheadends will be able to pick up the imported Baltimore signals directly.


SYSTEMS ARE OVERLAID AND INTERCONNECTED
TELECASTING NET SERVES PUBLIC
STRUCTURE
POINT-TO-POINT NET SERVES INSTITUTIONS*
STRUCTURE
REVERSE
FORWARD
0
30 MHz
260 MHz
REVERSE
FORWARD
0
135 MHz
260 MHz

SYSTEM UTILIZATION

- PUBLIC TV

  LOCAL PROGRAM ORIGINATION

  SOCIAL SERVICE PROGRAMS

  SPECIAL INTEREST PROGRAMMING

  2-WAY CAPABILITIES

    SUBSCRIBER RESPONSE
    ELECTRONIC INFORMATION HANDLING

  PAY TV

- CHANNEL LEASING

  BY HOUR
  BY YEAR

- SERVES THE GENERAL PUBLIC

SYSTEM UTILIZATION

- DEDICATED COMMUNICATIONS

MUNICIPAL	NURSING HOMES
EDUCATIONAL	PRISONS
HOSPITAL	REHABILITATION CENTERS
FEDERAL	CENTERS FOR HANDICAPPED
UNIVERSITIES	

- COMMERCIAL COMMUNICATIONS

  BUSINESS DATA
  2-WAY VIDEO

- CHANNEL LEASING

- LIMITED SWITCHING CAPABILITY

- SERVES SPECIFIC CUSTOMERS

* Institutions may also serve the public through the telecasting net.

FIGURE IV-1
UTILIZATION OF TELECASTING AND POINT-TO-POINT NET

The headends and studios will be constructed during the time that each Service Area is being phased into the WCS. The phases for construction are:

PHASE	SERVICE AREA
1	2,7
2	5,6
3	3,4
4	1,8
5	9

Each of the five phases will be completed in one year. The timing is shown later in the Milestone Charts, Figures IV-2 and IV-3.

As constructed, each subheadend could also import "distant" signals from perhaps Philadelphia or New York. These signals, relayed by microwave from distant pick-up points to the master headend, would be routed to the subheadends via a cable transport system.

In addition to topography, site selection involved locating origination studios and subheadends near universities or schools where feasible. Where this was not feasible, tower sites were chosen to be in commercial or special zones that permitted the required offices and radio tower construction. If school or university locations for studios cannot be obtained, commercial sites in the area of the school or university will be substituted.

It was decided that subheadends and studios need not be collocated in two cases. That is, it proved technically desirable to supply two Service Areas from one subheadend, with cable to connect the subheadend with studios in two pairs of Service Areas. Service Areas 6 and 9 share a subheadend as do Service Areas 3 and 4. The site for the

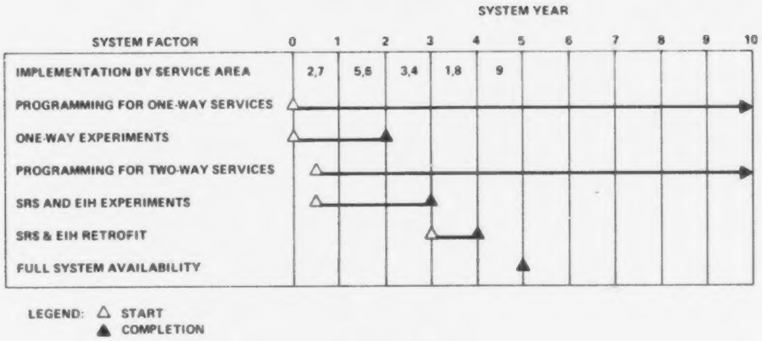


FIGURE IV-2
IMPLEMENTATION PLAN FOR WCS SYSTEM

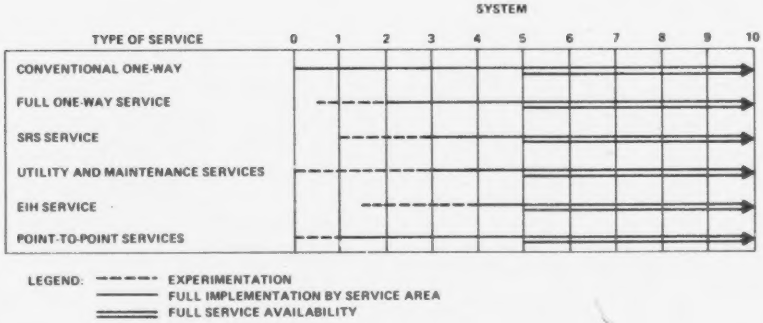


FIGURE IV-3
MILESTONE CHART FOR WCS SERVICES

master headend was chosen to be centrally located and on high ground. The master headend would have line-of-sight to all subheadends to permit a local distribution system via airlink if desired, although cable interconnection is planned for this purpose.

The general locations of the master headend and the six subheadends are shown in Figure II-1 of Section II. Signals from local stations could be received off-the-air at the master headend as well as at each subheadend except those for Service Areas 5 and 6. The latter two would receive local off-the-air signals via the master headend.

In order to provide high quality signals at the terminals, the master headend has been located so that less than 28 amplifiers will be cascaded in series between the master headend and any subscriber. In the case where local Washington signals are received at each subheadend, the subheadends have been located so that less than 18 amplifiers are cascaded between the subheadend and the most distant subscriber. These are worst case examples; in most cases, there will be fewer than half this number of amplifiers between a subscriber's connection and the origination point.

Each headend will eventually be provided with computers to be used with two-way subscriber response and frame-stopper terminals as new types of services are introduced to all service areas by the fifth year of operation. In Service Areas 2 and 7, computers will be installed immediately and experimentation with limited two-way will begin as quickly as the distribution plant is ready for operation.

The technical design features of both the computers and the two-way distribution systems are discussed in Appendix B.

Master Headend and Subheadend Interconnections

As indicated previously, the master headend will be interconnected with the six subheadends by means of a cable transport system as the subheadends are constructed. These interconnections will provide for real-time exchange of TV signals using one two-way video channel from each subheadend to the masterheadend. In addition, twelve channels will be provided for transmitting signals from the master headend to each of the subheadends.

A conventional cable transport system is tentatively recommended because uncertainties exist in the performance of air links, as discussed in Appendix B. The estimated costs of various alternatives are discussed below in the context of the Washington Cable System. The cost of alternatives consisting of two-way cable, Amplitude Modulated Link (AML), and Laser Link have been compared[2] for transport systems of equal capacity. The results of these analyses are shown in Table IV-1.

TABLE IV-1

CAPITAL COSTS OF ALTERNATIVE WCS TRANSPORT SYSTEMS

Two-Way Cable	$667,330
AML (air link)	$268,820
Laser Link (air link)	$274,000

Clearly air link systems would be cheaper and therefore would be preferred if performance proves acceptable.

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[2] J. J. O'Neill, "Technical and Economic Investigation of the Interconnection of WCS's Multiple Headends", The MITRE Corporation, WP-8542, Washington, D.C., 16 November 1972.

Further cost savings in the transport system (i.e., approximately $70,000 per subheadend) could be realized by eliminating the six subheadends. In this case, all off-the-air signals used by the WCS would be received at the master headend and distributed via air links to the various Service Areas. This would be possible, using air links, since the quality of signals received at the master headend and then "air-linked" to a Service Area would be about the same as for direct off the-air reception at Service Area subheadend. Acceptable off-the-air signals could not be provided via cable except to those Service Areas adjacent to Service Area 7.

Detailed measurements of the quality of signals transmitted via air-links should be made during the preconstruction planning phases of the Washington Cable System. Based on these tests a final decision would be made on whether to use an air-link transport system.

Leased Microwave for Relaying Distant Imported Signals

The telecasting net will utilize a Community Antenna Relay System (CARS) to carry "off-the-air" television signals and cablecasting signals to Washington from pick-up locations outside of Philadelphia and New York City. These signals will be received at the Washington master headend for dispersal throughout the telecasting net.

It has been assumed that a common carrier will supply the CARS service and will provide all necessary antennas and television broadcast receivers at the remote pick-up locations in addition to necessary microwave relay equipment. The costs of these leased microwave circuits from Philadelphia and New York have been included in the costs of the system alternatives discussed in Section VI and VII.

Distribution

The entire cable system projected for the WCS will have a potential for two-way transmission and will be able to provide up to thirty forward channels and four reverse channels per cable. The initial capability is limited by the linearity of commercially available amplifiers. In the system design, allowance has been made for reduced output levels, assuming that the 30 channel amplifiers are loaded to capacity. The spacing of these amplifiers will be made close enough to allow for the insertion losses expected when the bypass (backfeed) circuitry, needed to provide two-way services, is installed at each station.

The thirty channel system, with converters, was chosen over a 24 channel dual cable system, with no converters, primarily because of Washington's four strong, VHF television signals. It is estimated that these four local signals would reduce the capacity of the 24 channel dual cable approach even further, i.e., to 16 channels, because of direct pickup problems. For those sections of the city nearest

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3 This assumes that the 108 to 120 MHz Aircraft Navigation Band will be used for two video channels. However, the use of this band in the cable system will need further study and field trials when the channels become operational to verify that possible cable system would not interfere with this Aircraft Navigation Band.

Baltimore, direct pickup of the three Baltimore VHF's could further reduce the capacity of such a 24-channel dual cable system to only 10 channels.

A discrete switched cable system such as Rediffusion or Discade, was ruled out for the WCS because of the lack of flexibility with respect to future expansion, problems caused by the space requirements for their switching gear and for underground ducts for the large bundles of cables required, and the somewhat higher cost involved - particularly for the Rediffusion System.[4,5]

For the purpose of allowing additional expansion of channel capacity (either forward or reverse), a second cable will parallel the initial "operational" cable. Except in Service Areas 2 and 7, this duplicate non-energized cable system will not include, at the beginning, amplifiers, taps, splicing and other associated attachments. This is simple "raw" cable pulled in, tested and carefully capped to prevent the entrance of moisture into the cable. However, the drop for the second cable will be installed at each customer's location, at the time the first house drop is installed.

The second cable will be used in Service Areas 2 and 7 for the initial two-way experiments. The second cable will be completely

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[4] L. L. Stine, C. M. Plummer, M. A. Lambert, "Local Distribution of Telecommunications - A Perspective," The MITRE Corporation, M71-91.

[5] John E. Ward, "Present and Probable CATV Broadband Communication Technology," Appendix A of Sloan Commission Report, 1971.

energized from the start of operations and two-way service will be provided to 100 subscribers in the first year, 1,100 in the second year and 6,100 in the third year.[6] As two-way service is expanded to other service areas, the second cable will be energized. All two-way services will be provided on the second cable.

Terminals

A converter, described in Appendix B, will be provided to each new subscriber. An A/B switch will be included in the converter for future dual cable operation.

The subscriber response terminals, discussed in Appendix B, will be made available to a number of subscribers in Service Areas 2 and 7 and will be used as part of an experiment on the feasibility, operation, and maintenance of subscriber response terminals and limited two-way services. Additional numbers of subscriber response terminals would be introduced for experimental and finally regular use in all of the Service Areas as the system matures.

INITIAL POINT-TO-POINT NETS

Preliminary designs for four point-to-point nets have been specified and costed. These nets, which do not include the cost of subscriber terminal sets are:

1) A Federal data processing network; 10 miles in length and requiring approximately a $417,000 initial investment;

2) A Municipal net for police, fire, hospitals, public schools and others; 73 miles long and costing approximately $807,000.

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[6] See the Milestone Chart, Figure IV-3, page IV-19.

3) A commercial and institutional net for banks, stores, industry, and others; 50 miles in length and costing approximately $952,000, and

4) A higher education net that interconnects the colleges and universities in Washington; 15 miles long and costing approximately $183,000.

The fifty-mile commercial and institutional net is more expensive than the seventy-three mile Municipal net because the Municipal net has less underground plant. The short Federal net is more expensive than the higher education net because the Federal net has twice the channel capacity of the higher education net (see Table IV-2).

The Municipal and educational point-to-point nets would be designed to be interconnectable to the Washington telecasting net. The Federal net has been designed to be used primarily with data processing systems. It would provide primarily digital transmission, with some video. It could be interconnected to the telecasting net later if desired.

All point-to-point nets would be constructed as installation of the telecasting net progresses through each Service Area. This means that the Federal net would not be started until the fifth year (Service Area 9) and the Municipal net would not be completed until the end of the fifth year. This much time would be needed anyway to work out the use of this network as a part of the operating communications system of the government and to arrange the associated budgeting and funding

TABLE IV-2
POINT-TO-POINT NETS

	TYPE	NUMBER OF SUBS.	LENGTH (Miles)	APPROX. COST	NOTES
FEDERAL	Capitol Building & Major Federal Buildings	54	10	$ 417,000	1) Sixty channel system uses two oppositely directed 30 channel cables and includes a switching facility for use within the net.
MUNICIPAL	Schools, Fire, Police, Hospitals, Sanitation, etc.	271	73	$ 807,000	2) Uses subheadends which are co-located with the telecasting net 3) Privacy is maintained within each community of interest by virtue of converters that do not permit outsiders to obtain access to channel other than their own.
INSTITUTIONAL	Banks, Savings & Loans, Department Stores, Credit Associations, Utility Co., etc.	300 to 3000	50	$ 952,000	4) Same as Municipal 2) and 3)
HIGHER EDUCATION	American U., Catholic U., Federal City College, Georgetown Univ., George Washington U., Howard U., and the 17 other colleges of Washington, D.C.	23	15	$ 183,000	5) Thirty channels, fourteen one-way, sixteen the other way in a two-way system.

actions. Although the four point-to-point nets have been configured as separate cable runs, they need not be completely separate from the telecasting net. The point-to-point nets are, in fact, expected to share cable runs with the telecasting net in some areas because of the many routes that will be common to both. The preliminary needs analysis has indicated that each of the four point-to-point nets, Municipal, Federal, commercial and institutional, and higher education, would require the total capacity of an individual cable. On this basis, a separate cable net is provided for each in most parts of the city.

Traffic is expected to be primarily within each individual net, but some internet traffic will be accommodated. Also there will be some traffic between the point-to-point nets and the public telecasting net. This is expected to be primarily from the educational net.

A preliminary estimate of internet and intranet traffic is given in the Table IV-3. It shows that the proportion of intranet traffic is large compared to internet traffic, and that some nets, such as the commercial net, would have practically no internet traffic with the other nets.

TABLE IV-3

PRELIMINARY ESTIMATE OF TRAFFIC FLOW (PER CENT)

TO FROM	TELECASTING	MUNICIPAL	FEDERAL	EDUCATIONAL	COMMERCIAL
TELECASTING	100	0	0	0	0
MUNICIPAL	5	88	5	1	1
FEDERAL	0	5	94	1	0
EDUCATIONAL	10	3	1	85	1
COMMERCIAL	0	0	0	0	100

SIGNAL QUALITY DESIGN OBJECTIVES

The technical specifications which follow in Table IV-4 represent the design objectives proposed for the WCS system, including both the telecasting and point-to-point nets.[7] They are based on the provision of a "fine" grade of color television picture on each channel, at each subscriber connection point.

To relate this set of specifications to subjective studies, it is projected that 95% of all observers, at all parts of the system, will rate these pictures as a Television Allocation Study Organization (TASO) "fine". More than 50% will rate the picture as a TASO "excellent". The required signal-to-noise ratio to realize these TASO ratings is shown in Figure IV-4.[8]

More detailed technical specifications concerning the cable system will be required for the final design. These specifications would be prepared by the engineering contractor for the WCS at that time. The major specifications, presented here, were used to guide the tentative design and are indicative of what can be feasibly achieved with modern equipment.

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[7] These specifications meet or surpass the technical standards of the FCC, paragraph 76.605, Cable Television Report and Order, February 3, 1972. Many of the specifications here were not considered in the FCC report because of the problem of older systems not meeting the specifications.

[8] This figure is taken from R. A. O'Connor, "Understanding Television's Grade A and Grade B Service Contours," IEEE Transactions on Broadcasting, Vol. BC-14, No. 4, December 1968.

TABLE IV-4
TECHNICAL SPECIFICATIONS

Subscriber Receiver Input Level, Each Channel	+3 to +10 dbmV
Visual Carrier Frequency (above lower boundary of channel)	1.25 MHz± 250 kHz
Aural Carrier Frequency (above lower boundary of channel)	4.5 MHz ± 1 kHz
Signal-to-Noise Ratio	43 db
Cross Modulation Suppression (from wanted signal)	51 db
Ringing and Ghosting Suppression (from wanted signal)	40 db
Hum Suppression (from wanted signal)	60 db
System Differential Gain	±2 db
System Differential Phase	±3°
System Long Term Gain Stability (any channel)	±2 db
System Short Term Gain Stability (any channel)	±1 db

All signal levels are given in dbmV referenced to 1 mV across 75 ohms as 0 dbmV.

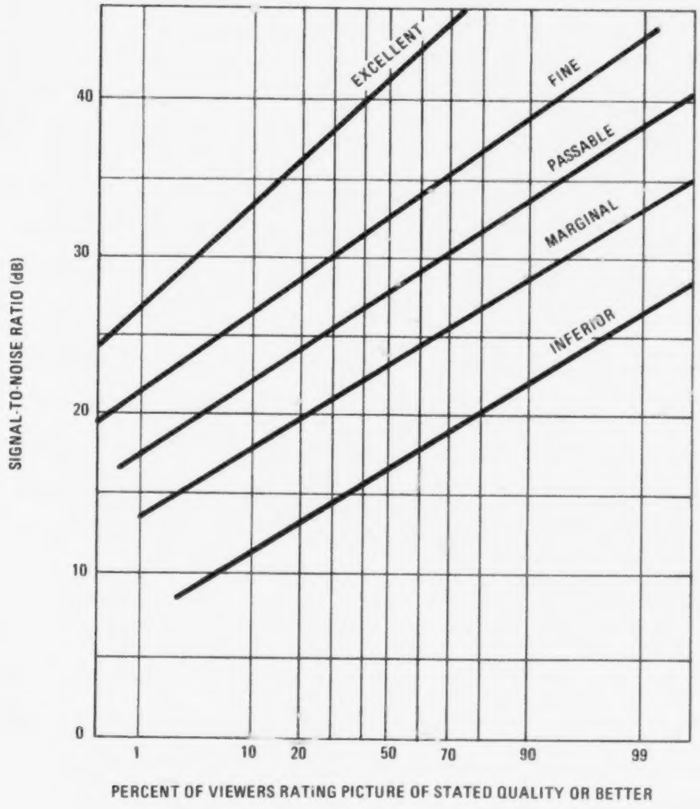

FIGURE IV-4
TELEVISION ALLOCATIONS STUDY ORGANIZATION (TASO) PICTURE RATINGS AS A FUNCTION OF SIGNAL-TO-NOISE RATIO

MAINTENANCE

The WCS will be staffed at a level of one service technician per 4,000 subscribers for all of the base cases considered in Section VI. Each service technician will be provided with a service vehicle. Maintenance technicians, service technicians, and bench technicians will all report to a chief technician who will be in charge of installation and maintenance for a particular sector of Washington. One chief technician will be employed to manage installation and maintenance for Service Areas 2 and 7, one for 5, 6, and 9, one for 3 and 4, and one for 1 and 8. Four chief technicians will be employed for the entire system. The number of maintenance technicians will be approximately one man per 150 miles of cable. There will be one bench technician per 200 miles of cable for this system. The above rules-of-thumb are based on cable system operating experience.

IMPLEMENTATION SCHEDULE

The initial one-way system, described earlier, is expected to evolve into a complete two-way system capable of providing any and all of the services discussed in Section III. The plans for the two-way telecasting system presented here are tentative and represent an alternative that seems both reasonable and desirable at this time. Definitive plans for the telecasting and point-to-point system can only be made later as the results of experiments become available and negotiations with large users (such as the lessee) of the point-to-point system are completed.

Preliminary estimates of the implementation phasing for both the WCS system and the programming and services that it would provide are shown in Figure IV-2. System installation would take place over a period of five years, as shown. The preparation of programming materials for both the one-way and two-way services would start at the beginning of system implementation and continue indefinitely. One-way experiments would start as soon as the system is operational and continue until the end of the second year. Likewise, two-way programming and hardware experiments would start at the same time and continue until the end of the third year. As mentioned earlier, in order to conduct these two-way experiments, one hundred two-way subscriber response terminals would be supplied in Service Areas 2 and 7 in the first year, 1,000 in the second year and 5,000 in the third year. Retrofitting of two-way Subscriber-Response terminals in Service Areas 2, 3, 4, 5, 6, and 7 would occur during the fourth year of system operation and Service Areas 1, 8, and 9 would be supplied with these terminals in the fourth and fifth years. The full system would be available at the end of the fifth year.

All services supplied by the WCS would also be available by the fifth year. Estimated milestones for these services are shown in Figure IV-3. Conventional one-way services would start as soon as the system is installed with other one-way services being added by the second year. Full implementation, as Service Area installations are completed, of two-way subscriber response services and utility and maintenance services would start at the beginning of the fourth year.

Two-way electronic information handling services would start by the fifth year. Point-to-point services would start as each service area is completed.

The implementation schedule for the WCS would result in a five year construction plan with an average system construction rate of 21 miles per month. This rate is conservative: based upon cable industry experience construction may proceed at rates of between 35 to 50 miles per month. For the purposes of this study we have assumed, therefore, that at least 70% of the construction for each phase will have been completed in the first six months of implementation.

CHANNEL ASSIGNMENTS FOR THE TELECASTING NET

Table IV-5 shows a set of possible channel allocations on the telecasting net, for the one-way, two-way subscriber response, two-way EIH, and utility services discussed above.

Cable 1 would be one-way throughout and would carry fifteen off-the-air local and imported signals, three cablecasting signals from other cable systems, or special events in distant parts of the country, as well as five leased channels with programming supplied by the lessee, two channels requiring programming by the WCS, and three channels requiring minor programming origination by the WCS.

Of the 28 possible channel allocations suggested for Cable 1 of the telecasting net (see Table IV-5), 6 channels would be accessible to the public. The tentative channel allocations shown for Cable 2 of the telecasting net would provide two additional channels for municipal and Federal Government cablecasting originations as well as 18 channels

TABLE IV-5
POSSIBLE CHANNEL ALLOCATIONS FOR WCS TELECASTING SYSTEM

CABLE 1 (Downstream)	Number	Class
1. Local Signals	7	A[1]
2. Imported Cable Signals	3	A
3. Imported Off-The-Air Signals	2	A
4. Continuous News, Time, Weather	1	D
5. Local Programming		
a. Public Access	2	1-B, 1-D
b. Local Origination	1	C
6. Special Interest Programming, Movies, and Sports	1	D
7. Dedicated Channels for Lease (1-way)	2	B
8. Public Information Channel		
a. T.V. Guide	1	D
b. Community Events, Ads	1	C
c. Health Services	1	B
9. Instructional Channels (1-way) for D.C. Schools and Universities	4	3-B, 1-D
10. Municipal Government Access Channel	1	D
11. Pay TV[4]	1	B
12. Unassigned[2]	2	
TOTAL	30[3]	

CABLE 2 (Downstream)	Number	Class
1. Imported Cable Signal	1	A[1]
2. Preference Polling and Shopping (2-way SR)	1	B
3. Alarm, Utility and Maintenance (2-way SR)	1	B
4. Professional Channel	1	B
5. Social Services (2-way EIH)	2	C
6. Interactive Educational Channel (2-way SR)	1	C
7. Interactive Entertainment Channel (2-way SR and EIH)	1	C
8. Individualized Shopping and Reservations	1	B
9. Banking and Credit	1	B
10. Computer-Aided Instruction	12	B
11. Special Services Channels	3	B
12. Pay TV[4]	1	
13. Unassigned[2]	4	
TOTAL	30[3]	

CABLE 2 (Upstream)	Number	Class
1. Data entry/request channels from terminal to headend or subheadends and video return channels (one return video channel can provide for many narrowband return channels)	4	D
TOTAL	4	

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[1] LEGEND FOR PROGRAMMING CATEGORIES
A - Off-the-air local or imported TV signals with no programming required by WCS.
B - Leased channels with programming supplied by lessee.
C - Channels requiring programming origination by WCS.
D - Channels requiring minor programming origination by WCS.

[2] The two channels of each cable in the aircraft navigation band would be held in reserve until field measurements to check radiation could be made.

[3] Each cable can provide for 30 downstream channels plus the 88 MHz to 108 MHz FM band.

[4] See Footnote Table II-2.

that would be directly accessible to the public. Thus a total of 24 of the 56 allocated channels on the two cables would be available for various public access purposes.

In addition, as will be seen in the next section, the channel allocations for the point-to-point network (see Table IV-8) provides a large number of channel pairs for two-way video information exchange between various Municipal and Federal government offices. The interconnection capabilities of the telecasting and point-to-point networks allow both the Federal or Municipal departments to transmit information directly to part or all of the District community.

By FCC regulations, the WCS must carry all local off-the-air signals. For some viewers, reception will be improved for all or some of the signals. There are seven Washington TV stations in all as shown in Table IV-6; two of the Washington, D.C. stations are independents, and two are educational television stations.

The current FCC policy has the practical effect of restricting the importation of off-the-air TV signals into the hundred largest markets. Recent FCC rules would permit the importation of two independent stations for a Washington cable system. Other educational TV stations can be imported if the local educational TV stations, i.e., WETA, Channel 26 and WNVT, Channel 53, do not object. The list of Baltimore and Philadelphia TV Stations shown in Table IV-7 are candidates for importation under the recent FCC rulings on importation.

The signal contours of Washington and Baltimore stations, as derived by Jansky & Bailey are shown in Figures IV-5 through IV-14.

TABLE IV-6
OFF-THE-AIR BROADCAST SIGNALS

Washington

1. WRC-TV	Channel	4	NBC
2. WTTG	"	5	IND
3. WMAL-TV	"	7	ABC
4. WTOP-TV	"	9	CBS
5. WDCA-TV	"	20	IND
6. WETA-TV	"	26	ETV
7. WNVT-TV	"	53	ETV

TABLE IV-7
CANDIDATE SIGNALS FOR DISTANT IMPORTATION

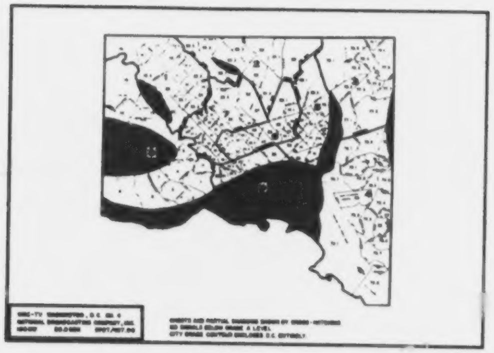
Philadelphia			
1. WPHL-TV	Channel	17	IND
2. WTAF-TV	"	29	IND
3. WUHY-TV	"	35	ETV
4. WKBS-TV	"	48	IND
Baltimore			
1. WMET-TV	"	24	IND
2. WBFF-TV	"	45	IND
3. WMPB	"	67	ETV
Other			
1. WHYY-TV (Wilmington, Del.)	"	12	ETV
2. WCYE (Richmond, Va.)	"	23	ETV

TABLE IV-8
WCTS SYSTEM
POSSIBLE CHANNEL ASSIGNMENTS FOR POINT-TO-POINT NETS
(14 TWO-WAY CHANNELS PER CABLE, 2-WAY VIDEO)

NET 1 - Municipal Government (One cable, 73 miles)	2-way Channels
1. Police and Courts	2
2. D.C. Schools	5
3. Mayor's Office	2
4. Fire Department	1
5. Hospitals	1
6. Highways	1
7. D.C. Library	2
	14
NET 2 - Educational Institutions (One cable, 15 miles)	
1. 23 Universities and Colleges	14
NET 3 - Business Organizations (One cable, 50 miles)	
1. Transit Company	1
2. Metro	1
3. Utility Companies	2
4. Banks	7
5. Store Nets	3
	14

NET 4 - Federal Government (Four cables, 10 miles each)

Sixty channel dual-cable system will provide two-way video or data links between 54 Federal Office Buildings


GHOSTS AND PARTIAL SHADOWING SHOWN BY CROSS-HATCHING
NO SIGNALS BELOW GRADE A LEVEL
CITY GRADE CONTOUR ENCLOSES D.C. ENTIRELY

, FIGURE IV-5

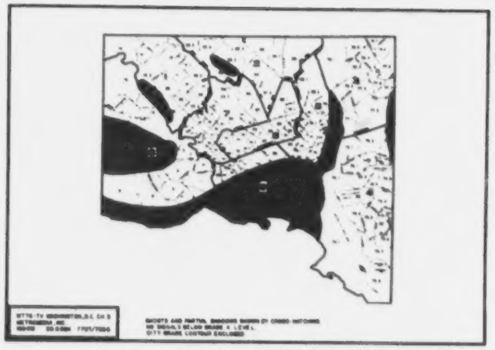

GHOSTS AND PARTIAL SHADOWING SHOWN BY CROSS-HATCHING
NO SIGNALS BELOW GRADE A LEVEL

FIGURE IV-6

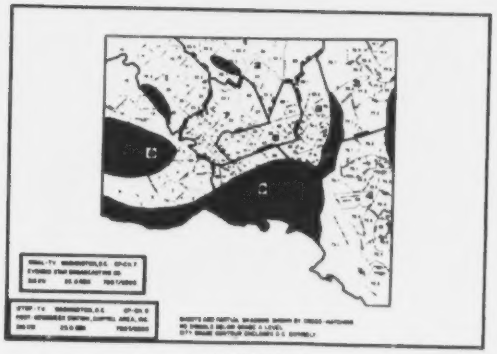

GHOSTS AND PARTIAL SHADOWING SHOWN BY CROSS-HATCHING
NO SIGNALS BELOW GRADE A LEVEL
CITY GRADE CONTOUR ENCLOSES D.C. ENTIRELY

FIGURE IV-7

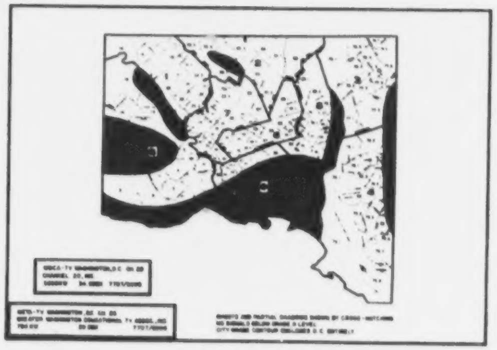

GHOSTS AND PARTIAL SHADOWING SHOWN BY CROSS-HATCHING
NO SIGNALS BELOW GRADE A LEVEL
CITY GRADE CONTOUR ENCLOSES D.C. ENTIRELY

FIGURE IV-8

SIGNAL CONTOUR MAP

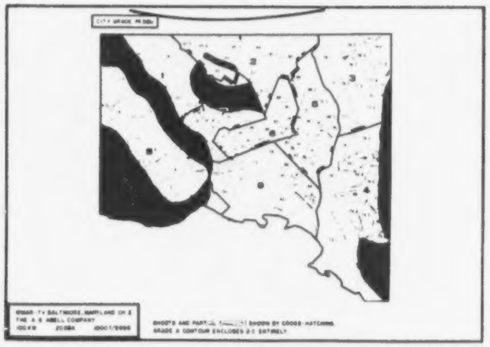

WMAR-TV BALTIMORE, MARYLAND CH 2
THE A S ABELL COMPANY
GHOSTS AND PARTIAL SHADOWS SHOWN BY CROSS-HATCHING
GRADE A CONTOUR ENCLOSES D.C. ENTIRELY

FIGURE IV-9

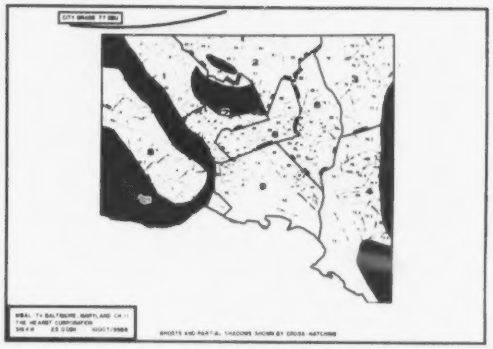

WBAL-TV BALTIMORE, MARYLAND CH 11
THE HEARST CORPORATION
GHOSTS AND PARTIAL SHADOWS SHOWN BY CROSS-HATCHING

FIGURE IV-10

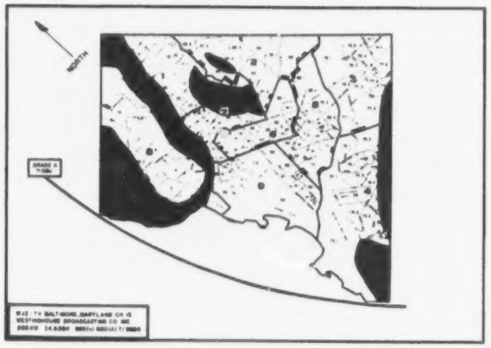

NORTH
WJZ-TV BALTIMORE, MARYLAND CH 13
WESTINGHOUSE BROADCASTING CO INC

FIGURE IV-11

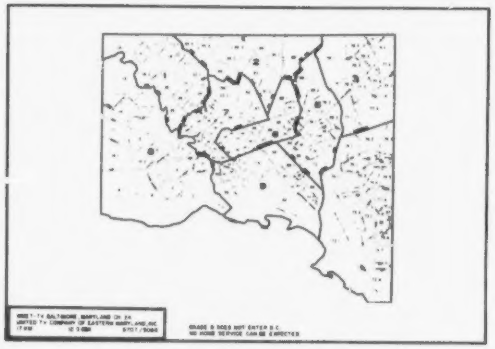

BALTIMORE, MARYLAND CH 24
UNITED TV COMPANY OF EASTERN MARYLAND, INC
GRADE B DOES NOT ENTER D.C.
NO HOME SERVICE CAN BE EXPECTED

FIGURE IV-12

SIGNAL CONTOUR MAP

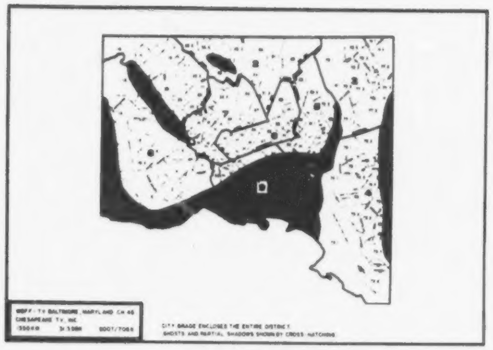

WBFF-TV BALTIMORE, MARYLAND CH 45
CHESAPEAKE TV, INC
CITY GRADE ENCLOSES THE ENTIRE DISTRICT
GHOSTS AND PARTIAL SHADOWS SHOWN BY CROSS-HATCHING

FIGURE IV-13

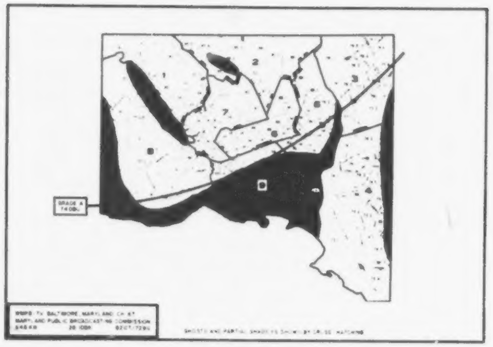

GRADE A
74 DBU
WMPB-TV BALTIMORE, MARYLAND CH 67
MARYLAND PUBLIC BROADCASTING COMMISSION
GHOSTS AND PARTIAL SHADOWS SHOWN BY CROSS HATCHING

FIGURE IV-14

SIGNAL CONTOUR MAP

These are based on reception with a 30 foot antenna with 0 dB of antenna gain for channels 2 to 13 and 8 dB of gain for channels 14 to 83 for the Grade contour.[10] A 30 foot antenna with 6 dB of gain for channels 2-13 and 13 dB of gain for channels 14 to 83 is assumed in determining the Grade B contour.

Jansky and Bailey surveyed the antennas in residential type dwellings in Washington in the late winter of 1970 and found that approximately 50 percent of the homes had roof top antennas. Since 93 percent of the homes have at least one television set in the Washington area, it can be assumed that the remaining 43 percent use rabbit-ear or built-in antennas. Only 6 percent of the homes used antenna structures that included a rotator and these were entirely VHF types. An insignificant number of the fixed antenna types were oriented to favor Baltimore stations.

From these data and the signal contours, one can conclude that reception of Baltimore signals is potentially TASO "fine" (see Figure IV-4) in approximately 80% of Washington. But, because of unfavorably oriented outdoor antennas and large usage of indoor antennas, the reception of Baltimore signals in the home is questionable in over 60% of Washington. More definitive statements on Baltimore reception would require field surveys based on viewer response.

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[10] R. A. O'Connor, "Understanding Television's Grade A and Grade B Service Contours," IEEE Transactions on Broadcasting, Vol. BC-14, No. 4, December 1968, p. 142.

As shown in Table IV-5, Cable 2 would be two-way throughout and would carry one cable signal imported from a distant city, twenty-three leased downstream channels with programming supplied by the lessee, and four downstream channels with programming supplied by the lessee, and four downstream channels requiring programming origination by the WCS. Cable 2 would also be supplied with four channels carrying information upstream for video return, as well as data entry and requests from subscriber terminals to the headend or subheadends of the WCS system. It is also assumed that some or all the two-way channels-for-lease would carry video return, downstream, from the headend or subheadend computers to the subscriber terminals.

Of the six channels, in the two cables that are assumed to carry programs requiring programming origination by the WCS (see Table IV-5), the programs of five would be provided on city-wide channels and one channel would carry local programs originated in each of the nine Service Areas of the District of Columbia. Estimates of the cost of the programming required for these six channels are given in Section VI.

CHANNEL ASSIGNMENTS FOR THE POINT-TO-POINT NETS

In addition to the telecasting services discussed above, the system will include the four special-purpose Point-to-Point cable nets described earlier in this Section to serve the Municipal Government, universities and colleges of the District of Columbia (e.g., American, Catholic, Federal City College, Georgetown, George Washington, Howard) various business organizations and the Federal Government, as indicated in Table IV-8. The channel assignments shown in this table should be considered a first estimate. In many cases, such as for the Municipal network, entire channels have been assigned to groups that may use an entire two-way channel in the introductory phase of the system. Point-to-point channel assignments can be changed at a later time if requirements in one area exceed initial expectations and requirements in another area are less than initial estimates.

SECTION V

DEMAND ANALYSES

INTRODUCTION

This Section discusses methods that have been used to estimate the demand for the various types of programming and cable services described in Section III.

Both conventional TV programming and new types of programming and services have been considered, including one-way, two-way subscriber response, and electronic information programming and services. Various mixes of these types of programming and services have been examined to optimize the expected demand for the Washington Cable System within the system constraints that will exist, including numbers of channels, types of distribution systems and terminals for each cable in each service area, programming and hardware costs, subscriber fees, numbers and timing of installation phases, and the recent FCC regulations which became effective on March 31, 1972, and which deal mainly with the types and numbers of imported signals that will be allowed in various markets, subject to copyright restrictions.

Specific methods of estimating potential demand for services that are discussed in this Section include the use of:

(1) Regression analysis of the demand for conventional cable system programming in other urban areas, as a means for estimating the demand for such a programming in Washington, D. C. In previous studies, this type of analysis has been applied to the problem of

estimating the effects of distant signal importation of the demand for a system that also carried network stations, independent stations and ETV stations.

(2) Surveys of market demand for innovative types of programs and services, including a review of available past surveys as well as a market survey conducted in Washington, D. C. by Howard University.

(3) Demonstrations of new programming and services, such as the one-way and two-way services demonstrated at Reston, Virginia, and Dayton, Ohio. At the conclusion of these demonstrations, a questionnaire is used to determine the extent and types of new programming and services desired by potential viewers and the fees that they would be willing to pay for them.

(4) In addition, in the future, on-line two-way subscriber response or polling devices will be used during actual full-scale system operation to determine the types of programs and new services desired by these subscribers.

Methods 3 and 4 have the advantage, over Method 2, of allowing the viewer to actually use the system and observe the programming and new services before evaluating them. These four methods are discussed in the text that follows, after which a summary of the results of the analyses that have been made of potential demand for the Washington Cable System is presented.

REGRESSION ANALYSIS METHODS

What fraction of Washington, D. C. households would be expected to subscribe to the Washington Cable System, as a function of time, as different services, including importation of distant signals, are provided? Several attempts have been made to develop models to predict the number of households that would subscribe[1,2,3,4] to a conventional CATV system as a function of the number of off-the-air broadcast TV signals available in the community, the subscriber fees, the average income of the households in the community, etc.

MITRE has examined these models, tested their applicability to Washington, D. C., and concluded that they are not particularly applicable since they represent situations that are significantly different from those that apply to the Washington Cable System. In particular, the CATV systems, from which the data used in these analyses were drawn, are mostly located where the number of available off-the-air signals is limited or reception is poor for some specific reason, i.e., either they are in rural communities where the distance from the TV transmitters is large, and the signals weak, or they are in urban areas where shadowing or multipath effects of

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[1] Comanor, William S., and Mitchell, B. M., "The Economic Consequences of the Proposed FCC Regulation on the CATV Industry," Attachment A to Comments of the National Cable Television Association before the Federal Communications Commission, December 1970.

[2] McGowan, John M., Noll, Roger G., and Peck, Merten J., "Prospects and Policies for CATV," Brookings Studies in the Regulations of Economic Activity, March 1971.

[3] McGowan, John J., Noll, Roger G., and Peck, Merten J., Comments before the Federal Communications Commission in Docket No. 18397-A, February 1971.

[4] Park, Rolla Edward, "Potential Impact of Cable Growth on Television Broadcasting," R-587-FF, The RAND Corporation, Santa Monica, California, October 1970.

buildings or terrain are pronounced. Viewers probably subscribe to such systems in large part to obtain improved reception from broadcast TV stations. Finally, these models are based on data from existing systems. Thus, data from systems that were started but failed are excluded. Such a data base will bias the results heavily. Estimates based on these types of systems would thus tend to overstate penetration expectations in Washington, where reception of local signals, in general, is not a problem. (See Figures IV-5 through IV-14)

Also, Washington has a larger number of local over-the-air signals available with better programming content and better signal reception than most of the communities in the samples used in these studies. In addition, none of the equations in References 1, 2, 3, and 4 account for such factors as the innovative one-way programming, or the two-way programming and services that would be provided by the Washington Cable System outlined in Section IV. Finally, Washington differs from most of the systems in the samples analyzed in many other ways (i.e., size, racial composition, recreational alternatives to television.) Some of these factors may have a large effect on potential penetration for the WCS.

More recently, another paper by Park on methods of predicting cable TV penetration has become available.[5] This paper resolves some of the problems of applying previous regression analyses to Washington, D.C. by including only those CATV systems where over-the-air stations in the vicinity provide levels of service roughly comparable to those in the 100 largest TV markets. However, the systems studied did not provide the types of innovative one-way and two-way services proposed for the Washington Cable System nor does the data base include data from systems that failed.

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[5] Park, Rolla Edward, "Prospects for Cable in the 100 Largest Television Markets," The RAND Corporation, R-875-MF, October 1971.

Specific examples of typical results from Reference 5 are shown in Table V-1. Table V-1 shows expected average penetration and, in parentheses, a likely range of penetrations for each typical top-100 market situation indicated. Lines 1 through 5 compare penetration estimates for markets with successively lower levels of local off-the-air service. Line 6 shows the effect on Line 2 of increasing the income per household in the area served. Line 7 shows the effect of a reduction in the subscriber fee from $5.25 per month to $3.00 per month, and Line 8 shows the effect of also carrying 3 distant network VHF signals that overlap the 3 local network VHF signals, normally carried by the cable system. Estimates of penetration are provided, for each of these lines, for cases with either overlapping signals or distant signals carried on the cable, and for cable systems located either in the middle of the market or on the edge of the "A" contour (i.e., the 35-mile zone).

Table V-1 indicates that conventional cable systems, when carrying local signals in the middle of markets where 6 or more local, off-the-air signals are available, supplying some local programming as well as mechanical originations, and charging an average of $5.25 per month

TABLE V-1
EXPECTED CABLE PENETRATION IN TOP-100 MARKETS: SOME HYPOTHETICAL EXAMPLES[a]
(SEE PARK REFERENCE 5)

LINE	LOCAL SIGNALS[b]	OVERLAPPING SIGNALS[b] ON CABLE	PENETRATION[c] (PERCENT) WITHOUT DISTANT SIGNALS MIDDLE[d]	PENETRATION[c] (PERCENT) WITHOUT DISTANT SIGNALS EDGE[d]	DISTANT SIGNALS[b] ON CABLE	PENETRATION[c] (PERCENT) WITH DISTANT SIGNALS MIDDLE[d]	PENETRATION[c] (PERCENT) WITH DISTANT SIGNALS EDGE[d]
(1)	3NV, 1IV, 2IU, 1EV	none	15 (10-23)	26 (17-36)	2I, 2E	20 (13-28)	32 (22-43)
(2)	3NV, 1EU	none	16 (10-23)	25 (17-35)	3I, 1E	22 (15-31)	34 (24-45)
(3)	2NV, 1NU, 1EU	none	20 (13-28)	30 (21-41)	2I, 1E	26 (18-36)	38 (27-50)
(4)	1NV, 2NU, 1EU	none	23 (16-33)	35 (25-46)	2I, 1E	30 (21-41)	43 (32-55)
(5)	3NU, 1EU	none	27 (19-33)	39 (28-51)	2I, 1E	35 (25-46)	48 (36-60)
(6)[e]	3NV, 1EU	none	20 (14-29)	31 (22-43)	3I, 1E	28 (19-39)	41 (30-53)
(7)[f]	3NV, 1EU	none	30 (21-41)	43 (32-55)	3I, 1E	39 (28-51)	54 (42-65)
(8)	3NV, 1EU	3NV	18 (12-26)	26 (18-37)	3I, 1E	25 (17-35)	35 (23-47)

[a] UHF set penetration used in the calculations depends on the number of local network UHF signals:

Local network UHF signals:	0	1	2	3
UHF set penetration:	.80	.90	.95	.99 .

Except as noted for lines (6) and (7), annual price of cable service is $63 and median family income is $10,000. Throughout, color set penetration is .5.

[b] N means network, I means independent, E means educational; V means VHF, U means UHF.

[c] The top figure is the most likely value. The figures in parentheses show an approximate 80 percent confidence interval; thus that there is about 1 chance in 10 that penetration will fall short of the lower figure, and 1 chance in 10 that it will exceed the higher figure.

[d] See the map (Figure 5 in Park's text, i.e., Reference 5) for locations.

[e] For line (6) only, median family income is $12,500.

[f] For line (7) only, annual price of cable service is $36, or $3 per month.

per subscriber, achieve average penetrations of about 15% when not carrying imported signals. When carrying imported signals, Table V-1 shows that the penetration can be expected to increase to a value of about 20%, i.e., an increase in penetration of about 33%.

OTHER PREVIOUS SURVEYS OF DEMAND

A number of sources of data are available from past surveys that can be used to give rough quantitative estimates of demand for cable services in urban areas such as Washington, D. C.

Table V-2 summarizes data from the Television Factbook[6] on existing conventional, one-way cable systems in the top 25 markets, which operate in areas where all three networks provide local off-the-air TV signals, and where off-the-air reception is considered good to excellent (except New York, and to some degree, San Francisco, where high buildings and hills cause shadowing and signal degradation). Good to excellent conditions are expected for the WCS system since Washington, which ranks number 9 in the top TV markets, lies in a relatively flat area where a moderate amount of shadowing exists (see Figures IV-5 through IV-14).

Table V-3 displays the results of a Delphi forecast (i.e., where expert opinions were used as the basis for forecasting) of the projected relative demand for various types of cable services. This analysis was prepared for the Office of Telecommunications of the Department

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[6] Television Factbook, Services Volume No. 40 (1970-71), Television Digest, Washington, D. C.

TABLE V-2
PENETRATION AND SUBSCRIBER FEES FOR REPRESENTATIVE EXISTING CABLE SYSTEMS IN THE TOP 25 MARKETS
(FROM TELEVISION FACTBOOK #40, 1970-71)*

CITY	MARKET RANK	NO.TV STAT.**	NUMBER OF SUBSCRIBERS	HOMES PER MILE	PENETRATION (subscribers/ homes passed)	YEARS OF OPERATION	ESTIMATED*** ASYMPTOTIC PENETRATION	CHANNEL CAPACITY	SUBSCRIBER FEE
New York, N.Y. (Sterling)	1	N-3 I-6 E-2	19,541	855	29%	4	35%	13	$5.90
Los Angeles, Cal. (Theta Cable)	2	N-3 I-6 E-1	17,653	120	22%	4	27%	12	$5.00
San Francisco, Cal	7	N-3 I-4 E-1	15,000	300	33%	18	33%	12	$6.25
Atlanta, Georgia	17	N-3 I-2 E-1	1,360	220	9%	2	22%	12	$5.95
Seattle, Wash	24	N-3 I-0 E-1	10,300	140	41%	19	41%	12	$5.00
Seattle, Wash.	24	N-3 I-0 E-1	900	78	13%	4	16%	12	$5.95
Seattle, Wash.	24	N-3 I-0 E-1	1,300	59	6%	3	9%	20	$6.90

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*Includes all systems in top-25 markets for which data are available

**N=Network Station; I=Independent Station; E=Educational TV Station

***Based on Standard Growth Curve of Reference 1.

TABLE V-3
BRIEF DESCRIPTIONS OF POTENTIAL HOME INFORMATION SERVICES AND ESTIMATED DISTRIBUTION OF MARKET SIZE

1. COMPUTER-AIDED SCHOOL INSTRUCTION. (19%) At the very minimum, the computer determines the day's assignment for each pupil and, at the end of the day, receives the day's progress report. At its most complex, such a service would use a real-time, interactive video color display with voice input and output and an appropriate program suited to each pupil's progress and temperament.

2. PERSON-TO-PERSON--PAID WORK AT HOME. (15%) Switched video and facsimile service substituting for normal day's contacts of a middle-class managerial personnel where daily contacts are of mostly routine nature. May also apply to contacts with the public of the receptionist, doctor, or his assistant.

3. PLAYS AND MOVIES FROM A VIDEO LIBRARY. (10%) Selection of all plays and movies. Color and good sound are required.

4. COMPUTER TUTOR. (7%) From a library of self-help programs available, a computer, in an interactive mode, will coach the pupil (typically adult) in the chosen subject.

5. CASHLESS-SOCIETY TRANSACTIONS. (5%) Recording of any financial transactions with a hard copy output to buyer and seller, a permanent record and up-dating of balance in computer memory.

6. ADULT EVENING COURSES ON TV. (4.5%) Noninteractive, broadcast mode, live courses on TV--wider choice of subjects than at present.

7. NEWSPAPER, ELECTRONIC, GENERAL. (4%) Daily newspaper, possibly printed during the night, available in time for breakfast. Special editions following major news breaks.

8. COMPUTER-ASSISTED MEETINGS. (4%) The computer participates as a partner in a meeting, answering questions of fact, deriving correlations and extrapolating trends.

9. CORRESPONDENCE SCHOOL. (3.5%) Taped or live high school, university, and vocational courses available on request with an option to either audit or graduate. Course on TV, paper support on facsimile.

10. HOUSEHOLD MAIL AND MESSAGES. (3%) Letters and notes transmitted directly to or from the house by means of home facsimile machines.

11. MASS MAIL AND DIRECT ADVERTISING MAIL. (3%) Higher output, larger-sized pages, color output may be necessary to attract the attention of the recipient--otherwise similar to item 10 above.

12. DEDICATED NEWSPAPER. (2%) A set of pages with printed and graphic information, possibly including photographs, the organization of which has been predetermined by the user to suit his preferences.

13. BANKING SERVICES. (2%) Money orders, transfers, advice.

14. CONSUMERS' ADVISORY SERVICE. (2%) Equivalent of Consumer Reports, giving best buy, products rated "acceptable", etc.

15. SHOPPING TRANSACTIONS--STORE CATALOGS. (1.5%) Interactive programs, perhaps video-assisted, which describe or show goods at request of the buyer, advise him of the price, location, delivery time, etc.

TABLE V-3 (CONCLUDED)
BRIEF DESCRIPTIONS OF POTENTIAL HOME INFORMATION SERVICES AND ESTIMATED DISTRIBUTION OF MARKET SIZE

16. SECRETARIAL ASSISTANCE. (1.5%) Written or dictated letters can be typed by a remotely situated secretary.

17. ANSWERING SERVICES. (1.5%) Stored incoming messages or notes whom to call--possibly computer logic recognizing emergency situation and diverting the call.

18. GROCERY PRICE LIST, INFORMATION, AND ORDERING. (1.5%) Grocery price list is used as an example of up-to-the-minute, updated information about perishable foodstuffs. Video color display may be needed to examine selected merchandise. Ordering follows.

19. LEGAL INFORMATION. (1.5%) Directory of lawyers, computerized legal counseling giving precedents, rulings in similar cases, describing jurisdiction of various courts and changes of successful suits in a particular area of litigation.

20. SPECIAL SALES INFORMATION. (1.5%) Any sales within the distance specified by the user and for items specified by him will be "flashed" onto the home display unit.

21. ACCESS TO COMPANY FILES. (1%) Information in files is coded for security, regularly updated files are available with cross-references indicating the code where more detailed information is stored. Synthesis also may be advisable.

22. LIBRARY ACCESS. (1%) After an interactive "browsing" with a "librarian computer" and a quotation for the cost of hard copy facsimile or a slow-scan video transmission, a book or a magazine is transmitted to the home.

23. DAILY CALENDAR AND REMINDER ABOUT APPOINTMENTS. (1%) Prerecorded special appointments and regularly occurring appointments stored as a programmed reminder.

24. WEATHER BUREAU. (1%) Country-wide, regional forecasts or special forecasts (farmers, fishermen), hurricane and tornado warnings similar to current special forecast services.

25. INDEX, ALL SERVICES SERVED BY THE HOME TERMINAL. (1%) Includes prices or charges of the above, or available communications services.

26. MESSAGE RECORDING. (0.5%) Probably of currently available type but may include video memory (a patient showing doctor the rash he has developed).

27. PAST AND FORTHCOMING EVENTS. (0.5%) Events, dates of events, and their brief description; short previews of future theater plays; and recordings of past events.

28. BUS, TRAIN, AND AIR SCHEDULING. (0.5%) Centrally available information with one number to call.

29. RESTAURANTS. (0.25%) Following a query for a type of restaurant (Japanese, for instance), reservations, menu, prices are shown. Displays of dishes, location of tables, may be included.

30. FARES AND TICKET RESERVATION. (0.25%) As provided by travel agencies now but more comprehensive and faster. Cheapest rates, information regarding the differences between carriers with respect to service, menus, etc. may be available.

of Commerce by the Institute for the Future.[7] It predicts an annual market of $20 billion for the future cable communiction services described in Table V-3, with the distribution of demand as shown in parentheses.

WASHINGTON MARKET SURVEY

In order to assist in decisions concerning the types of services to be provided by the Washington Cable System, a demand survey was conducted by Howard University under subcontract to MITRE.[8] A number of specific questions were asked of a representative sample of the Washington population as a basis for forecasting future demand for the services that will be offered by the system. One obvious advantage of this type of survey, over the regression analysis approach and other previous surveys, is that it uses data obtained specifically in the Washington area rather than basing predictions on operating experience in other urban areas.

The Howard survey was designed to determine the incremental demand for different types of programming and new services as a function of the size of the subscriber fees that would be charged. These specific results have been used in financial analyses of the WCS, described in Section VI, to determine the economic viability of providing these services at the prices the potential subscribers are willing to pay.

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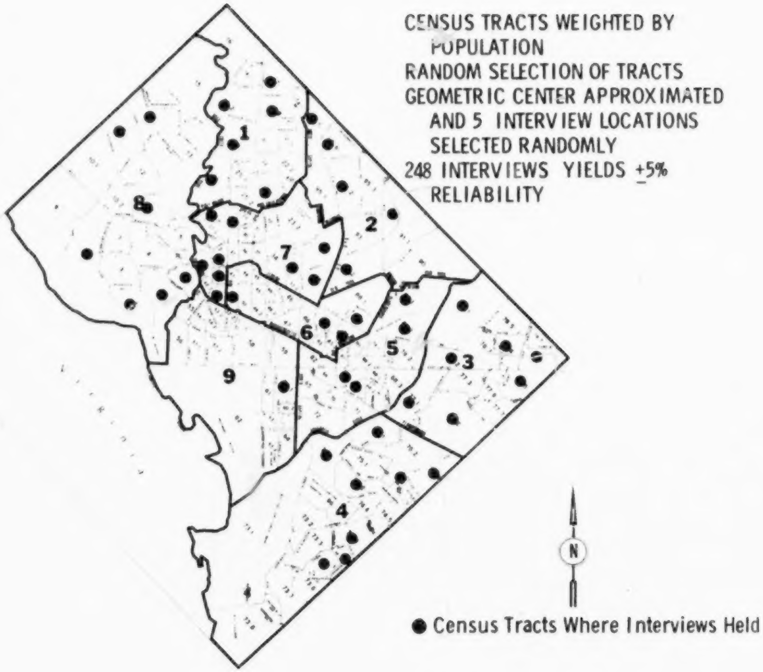
[7] Baran, Paul, "Potential Market Demand for Two-Way Services for the Home (1970-1990)," Institute for the Future, R-26, December 1971.

[8] "Marketing Research on Acceptability of Cable Television Services to District of Columbia Residences," Howard University School of Business and Public Administration, August 1971.

The Howard survey consisted of 248 interviews of heads of households, selected randomly from a tabulation of the 1970 census tracts (see Figure V-1). The interviewing technique used was a focused frame-of-reference structured interview. Since cable television is a novel concept to many people, the interviewer described the system before asking key questions. This explanation was supplemented by exhibits illustrating in a non-persuasive manner how cable television works. All interviewers were thoroughly trained in this focus technique. A validation of a high proportion of interviews was made using a follow-up telephone call-back.

Before summarizing the findings of this survey, a few caveats should be considered. This survey was basically a concept evaluation. In an actual purchasing situation, householders may be willing to pay more or less than indicated depending on advertising and alternative pressures on their income. In addition, the lack of specific descriptions of the services may have resulted in some uncertainty in the price potential subscribers would actually be willing to pay (see the questionnaire, Table V-4). In particular, note that question No. 4 mentions the Baltimore Colts professional football games as one of the possible sports programs. Subsequently, it was found that these games would be excluded from the Washington cable under the recent FCC cable regulations concerning sports blackouts. On the other hand, a number of other types of one-way and two-way services that could be provided were not included in the questionnaire.

The following is a summary of the information provided by the Howard University survey of Washington, D. C. Of all families contacted,



CENSUS TRACTS WEIGHTED BY POPULATION
RANDOM SELECTION OF TRACTS
GEOMETRIC CENTER APPROXIMATED AND 5 INTERVIEW LOCATIONS SELECTED RANDOMLY
248 INTERVIEWS YIELDS ±5% RELIABILITY

● Census Tracts Where Interviews Held

FIGURE V-1
HOWARD UNIVERSITY SURVEY PARAMETERS

TABLE V-4
MARKET SURVEY QUESTIONS ON SERVICES

If this kind of service becomes available in your building, or your block, do you think you would be interested in it? ☐ Yes ☐ No

1. How much would you be willing to pay per month for cablevision to improve the quality of your present picture-including excellent reception of Baltimore channels? (CIRCLE CLOSEST DOLLAR)

   0 1 2 3 4 5 6 7 8 9 10 more

2. How much additional would you pay per month for cablevision services on special channels which bring in weather reports; latest ball game scores and race results; hourly stock market quotations; reports on other local activities and meetings applying to your immediate community and neighborhood? (CIRCLE CLOSEST DOLLAR)

   0 1 2 3 4 5 6 7 8 9 10 more

3. In addition to the above amounts how much more would you pay per month to see a brand new movie every week on your television set (four new movies per month)? (CIRCLE CLOSEST DOLLAR)

   0 1 2 3 4 5 6 7 8 9 10

4. In addition to the above amounts, how much more would you pay per month for cablevision if it brought you live - all Baltimore Colts professional football games, and the probasketball and hockey games from Madison Square Garden in New York? (CIRCLE CLOSEST DOLLAR)

   0 1 2 3 4 5 6 7 8 9 10

5. In addition to the above amounts, how much more per month would you pay for cablevision to bring in high school or college courses which you could take in your home whenever you wanted and for which you could get credit if you wish? (CIRCLE CLOSEST DOLLAR)

   0 1 2 3 4 5 6 7 8 9 10 more

6. In addition to the above amounts, how much would you pay for an automatic burglar alarm system which notifies police immediately if someone is breaking in and gives police your exact address? (CIRCLE CLOSEST DOLLAR)

   0 1 2 3 4 5 6 7 8 9 10 more

7. In addition the above amounts, how much would you pay to be able to examine special shopping choices on your TV and order by push button. (CIRCLE CLOSEST DOLLAR)

   0 1 2 3 4 5 6 7 8 9 10 more

8. In addition to above amounts, how much would you pay per month for the chance to talk back to your television set and vote on political issues; types of programs you want; and many other things by using push buttons in your home? (CIRCLE CLOSEST DOLLAR)

   0 1 2 3 4 5 6 7 8 9 10 more

85% expressed an interest in cable television and willingness to pay a monthly fee of at least one dollar per month for at least one service. Of the eight groups of services proposed in the survey (see Table V-4), the interest in receiving the services described varied from 75% for the most popular service (i.e., new movies*) to 52% for the least popular (i.e., shopping aids). Table V-5 presents the percentage of those interviewed who were interested in subscribing and the average subscriber fee that those interviewed would be willing to pay for each service.

The first four services on Table V-5 (i.e., improved pictures, special channels, new movies, and sports events) represent typical one-way services that would be provided on the first cable. The last four services, i.e., educational services, burglar alarm, shopping aids and subscriber polling, represent typical two-way services that would be provided on the second cable. Of the latter, burglar alarm, shopping aids, and subscriber polling could be categorized as two-way subscriber response services and educational services as either two-way subscriber response or two-way electronic information-handling services. The Howard Survey was not specifically designed to estimate the penetration of many of the electronic information-handling services that might be made available on future two-way cable systems.

Figure V-2 is a histogram showing the distribution of total monthly fees that potential subscribers in the Washington Area indicated that they would be willing to pay for the four one-way and four

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*These would primarily be second-run rather than first-run new movies.

TABLE V-5
POTENTIAL SUBSCRIBERS TO WIDEBAND CABLE SERVICES
RESULTS OF HOWARD UNIVERSITY SURVEY

TYPE OF SERVICE	TYPE OF SYSTEM REQUIRED	PERCENT INTERESTED IN SPECIFIC SERVICE*	AVERAGE FEE THEY WOULD PAY
1. Improved off-the-air Signals	one-way	68%	$2.84/mo.
2. Special Channels	one-way	63%	$2.18/mo.
3. New Movies	one-way	75%	$2.67/mo.
4. Sports Events	one-way	66%	$2.80/mo.
5. Educational Services	two-way	66%	$2.73/mo.
6. Burglar Alarm	two-way	67%	$2.86/mo.
7. Shopping Aids	two-way	52%	$2.10/mo.
8. Subscriber Polling	two-way	58%	$2.00/mo.

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*Interested and willing to pay at least $1 per month extra for the specific service.

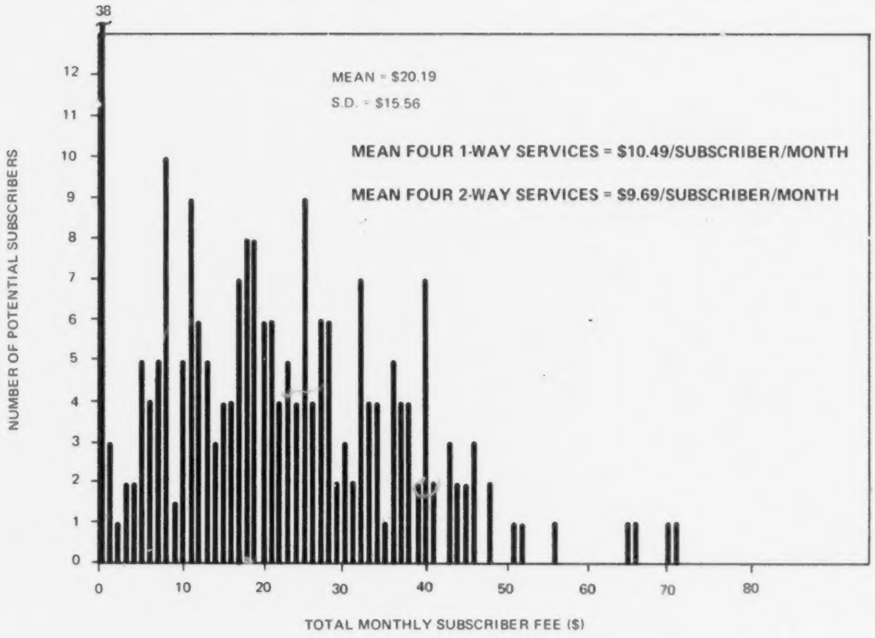

FIGURE V-2
DISTRIBUTION OF TOTAL SUBSCRIBER FEE FOR FOUR 1-WAY AND FOUR 2-WAY SERVICES

two-way services identified in the Howard University survey. The survey indicates a willingness to pay, on the average, up to $20.19 per month for these services.

Figure V-3 indicates the variation of the expected final penetration of various types or combinations of services including:

1. Improved Washington and Baltimore signals only
2. All four one-way services plus all four two-way services
3. The four one-way services only
4. The favorite single one-way service plus the favorite single two-way service, and
5. The favorite single one-way service only.

The rationale for including combinations 4 and 5 in the analyses that will be presented in Section VI is that they could represent lower-bound cases in the event that the interviewees might have misunderstood the incremental nature of the questions concerning "willingness to pay" for the services, as presented in Table V-4 (i.e., each question, after the first one, asks the interviewees what additional amount of money they would be willing to pay per month for each additional service). This lower-bound case might also be used to account for those who said they would pay for specific services during the interview, but because of the actual expense at the time the service was offered would decide not to subscribe.

Figure V-4 compares the Howard Survey results for question 1 (i.e., how much would the interviewee be willing to pay for improved Washington and Baltimore signals) with those that would be predicted

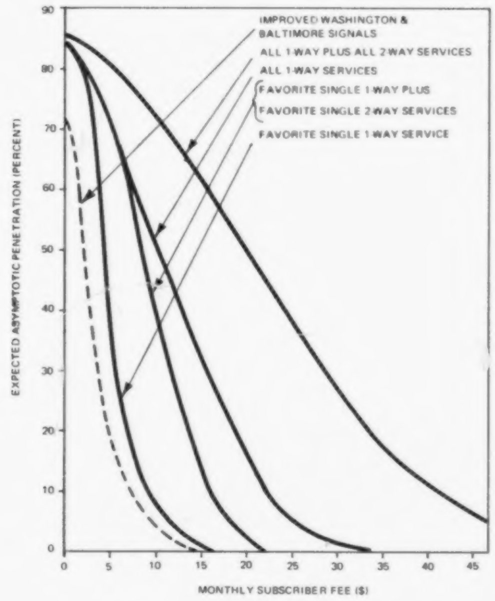

FIGURE V-3
RELATIONSHIP OF EXPECTED FINAL PENETRATION TO MONTHLY SUBSCRIBER FEE FOR VARIOUS COMBINATIONS OF SERVICE

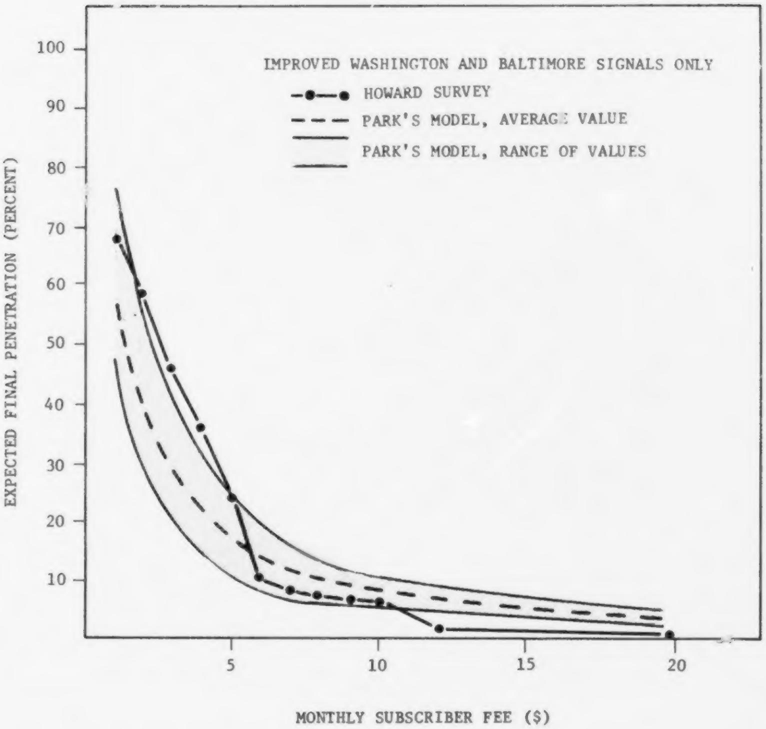

FIGURE V-4
COMPARISON OF PARK'S MODEL AND HOWARD SURVEY
FOR WASHINGTON D.C.

by Park's Model[9] under the same conditions (see Table V-1). In deriving these predictions of penetration versus subscriber fee based on Park's Model, adjustments have been made to account for the number of local and overlapping signals involved and the average income of Washington households. Both the average values of penetration and the likely range of penetration (see Table V-1) are plotted in Figure V-4 as a function of monthly subscriber fee. Note that the Howard Survey results indicate larger expected penetrations than predicted by Park for low subscriber fees and show a sharp drop in expected penetration as the subscriber fee exceeds either $5 per month per subscriber or $10 per month per subscriber. These latter values probably represent psychologically appealing levels of fee.

SMALL SCALE MARKET TEST METHOD

A more direct method of predicting demand for various types of programming and services that would be provided in a full-scale system. Appropriate questionnaires could then be used to gather data on the types of programming and new services preferred, as well as the estimated demand for the various types as a function of price.

A survey of this type has been conducted through the use of a demonstration of a number of one-way and two-way services, using the MITRE Time-shared, Interactive Computer-Controlled Information

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[9] Park, Rolla Edward, op. cit., Reference 5.

Television (TICCIT)[10,11] system that is operating on the Reston, Virginia, cable system. Such a demonstration was also conducted in Dayton, Ohio, in January 1972.

The special home terminals utilized in these demonstrations consist of a standard home television receiver, a video tape recorder with a built-in video frame refresh device, a specially designed coupler/decoder, plus a data entry keyboard to provide both one-way and two-way frame-stopping services of various types. The user initiates the process by calling the computer. At present, this is being done via the local telephone system. The computer then sends a directory of its services which is displayed to the reader on his home television screen. The user sends his viewing choice to the computer by using his telephone touchtone pad as a data entry device. The computer sends the first frame of the chosen topic which is displayed on the TV screen. When the viewer is finished with any frame, he sends a new message to the computer and the computer relays the next frame that is selected by the viewer. In addition, two-way services, such as polling, meter reading, burglar and fire alarms, requiring only a simple subscriber response terminal, could be demonstrated with the MITRE system by bypassing the frame-stopping device used in the system.

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[10] Stetten, K. J., "TICCIT: A Delivery System Designed for Mass Utilization," The MITRE Corporation, M71-56, October 1971.

[11] Volk, J., "The Reston, Virginia, Test of The MITRE Corporation Interactive Television System," The MITRE Corporation, MTP-352, May 1971.

Table V-6 presents the results of the demand survey MITRE has conducted in conjunction with demonstrations at Reston and Dayton. These results, shown in Table V-6, have been derived from a tabulation of 384 questionnaires. It should be noted that the respondents at Reston and Dayton came from all parts of the nation to see these demonstrations and, therefore, do not represent any specific geographic community. They are, by and large, representatives of government, industry, and educational institutions and, in general, are knowledgeable in the CATV field.

Figure V-5 shows the expected final penetration of an EIH system as a function of monthly subscriber fee based on the results of the Reston/Dayton survey. Note that the results for the Reston/Dayton survey are somewhat different than the Howard results for all one-way plus two-way services.

A more accurate marketing survey of new programming and services might be undertaken by either arranging for appropriate heads of District households to view the Reston system and the MITRE demonstrations before completing their questionnaires, or by providing an early demonstration of a system such as this in Washington, D.C. Capabilities for such "mini-demonstrations" have been incorporated into the proposed WCS design so that feedback can be obtained quickly concerning the relative popularity of the new services planned for the system.

SUBSCRIBER RESPONSE OR POLLING

Once the WCS is in full operation the subscriber response described in Appendix B, can be used for on-line sampling of subscriber demands

TABLE V-6
RESTON/DAYTON DEMONSTRATION SURVEYS

	% INTERESTED IN SPECIFIC SERVICE	AVERAGE MONTHLY FEE THEY WOULD PAY
1. New One-Way Services	63%	$2.03
Detailed local weather reports (including school closings)		
Most active stocks and prices on NYSE and AMEX		
Special sales at local stores		
Daily classified ads		
TV guide listings		
Ski condition reports		
New library acquisitions		
Commuter bus route schedules		
Daily school lunch menus		
2. Calendar of Events for Community Organizations, Cultural Activities, etc.	63%	$ .75
3. Personal address and telephone reference (using TV screen instead of phone book)	30%	$ .68
4. Personal stock profile (current price and volume listing on your own portfolio)	36%	$1.70
5. Home calculator (uses touchtone phone as keyboard)	66%	$3.34
6. Simple computer-aided instruction courses in algebra, French, car repair, or any other generally popular subject (course choices to be changed frequently)	85%	$5.98
*7. Burglar and fire alarm	90%	$1.09
*8. Remote shopping	50%	$1.04
*9. Library services	55%	$ .78

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*Dayton only.

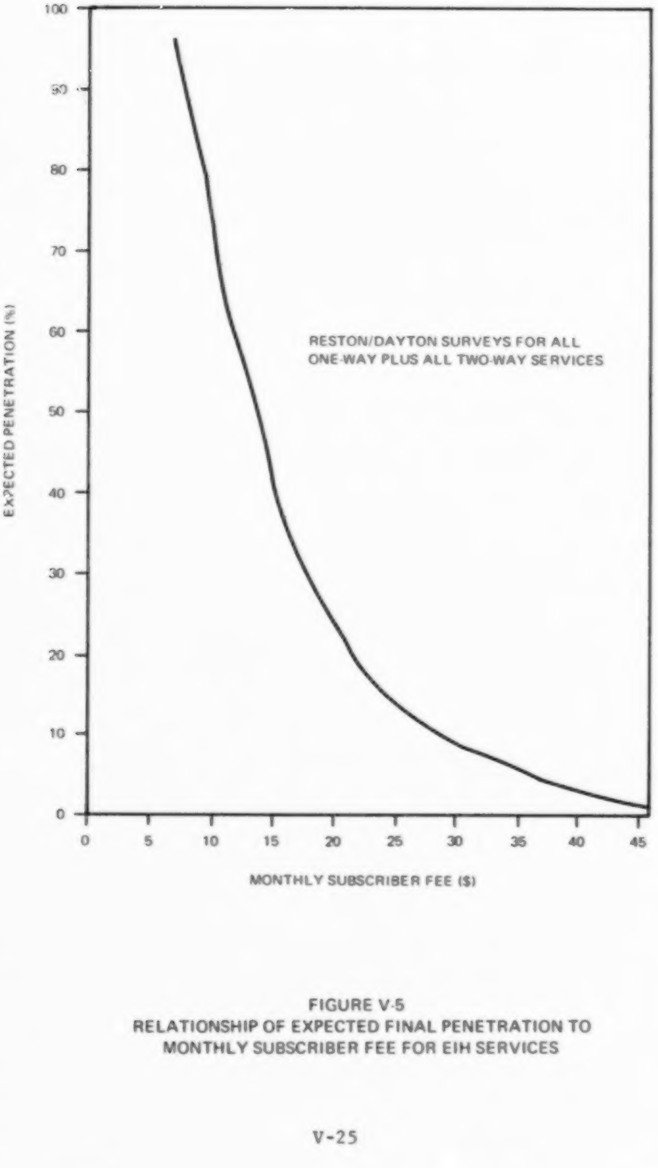

FIGURE V-5
RELATIONSHIP OF EXPECTED FINAL PENETRATION TO
MONTHLY SUBSCRIBER FEE FOR EIH SERVICES

for different types of programming as well as the different types of new one-way and two-way services that can be provided by the system. Subscribers would express their degree of preference for different programs and services while they were being viewed or used. These opinions would be collected and analyzed by a polling computer at the headend of the cable system. The results would be analyzed periodically and used to optimize the programming mix and channel allocations for conventional broadcast programming, additional one-way programming, and various types of two-way services.

Hopefully, it will be possible to use this method to maximize the system penetration for any given set of subscribers. Because of the large numbers of channels that will be available in the WCS, the channels can be allocated so that the system can respond not only to the demands of the majority but also can provide a number of programs and services for diverse minority groups such as local ethnic groups, chess players, job seekers, and the like.

POTENTIAL DEMAND FOR TELECASTING SERVICES

All of the above sources of information, including primarily the Howard University survey, but also the demand models, data on CATV systems from the Television Factbook No. 40 (1970-71), other CATV market analysis surveys, and expert opinion, have been used to establish a MITRE estimate of both the incremental increase in demand and expected penetration for the WCS, as a function of subscriber fees charged, as different types of telecasting services are added to the system. These estimates are summarized in Table V-7, in terms of Conventional One-Way services, Additional One-Way services, Subscriber-Response services, and Electronic Information-Handling services. Various examples of specific types of services that would be included under each of these categories are also shown in Table V-7.

One-Way Services

Based on these surveys of demand for one-way services, a thirty-channel WCS system, carrying a full complement of one-way services of the type shown under categories 1 and 2 of Table V-7 might be expected to achieve a final penetration of 56% to 76%, at a subscriber fee of $3.50 per month (from Figure V-3).

Subscriber-Response

As discussed in Section III, two-way Subscriber-Response Systems offer the possibility of providing new types of programming and services that are unique to cable systems. On the basis of the Howard survey such subscriber-response services appear to be effective in increasing the acceptable subscriber fees of urban systems, such as the WCS, while maintaining the levels of penetration expected for one-way systems at $3.50 per month per subscriber. The Howard University survey indicates that an additional fee of $3.00 per month per subscriber for two-way subscriber response services on the second cable, of the types shown in Table V-7, might be expected to result in a penetration of 65% to 78% for the WCS (from Figure V-3).

The above estimates do not cover the demand for the utility and maintenance communication services, that could be handled by the

TABLE V-7
ESTIMATED PENETRATION FOR WCS TELECASTING NET AS A FUNCTION OF SUBSCRIBER FEE AND LEVEL OF SERVICE

LEVEL OF SERVICE	ESTIMATED PENETRATION
A monthly subscriber fee of $ 3.50 for the following services:	
Conventional One-Way Services	
. Local off-the-air signals	18% to 33% penetration
. Continuous news, time, weather, etc.	
. Imported off-the-air signals	Increase to 24% to 44% penetration
Additional One-Way Services	Increase to 56% to 76% penetration
. Imported cable signals . FM radio . New movies and sports features . Local programming . Educational access . Municipal government access . Public information services . Instructional programming . Health services . Special interest programming . Communications for pay TV, professional channels and other private modes	
An additional monthly subscriber fee of $3.00 for the following services:	
Subscriber Response Services	63% to 78% penetration
. Interactive entertainment . Interactive education . Preference polling . Catalogue shopping . Communications for alarms . Communications for utility and maintenance services[*] . Communications for pay TV, professional channels and other private modes	
An additional monthly subscriber fee of $8.50 to $15.50 for the following services:	
Electronic Information-Handling Services	20% to 60% penetration
. Computer-aided instructions . Interactive entertainment . Social services . Video library . Individualized shopping and reservations . Banking and credit . Public information services	

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[*] In the base cases for the financial analyses (see Section VI) it was assumed that utility and maintenance companies would pay $2 per month per customer, and that the penetration would be 100% for this service.

Subscriber-Response System, and which would be separately billed to utility and maintenance companies. The demand for these utility and maintenance services, such as meter readings, automatic billings, load monitoring, and selective load control will, in all probability, be determined on the basis of the economies and trade-offs that such services could provide when compared to present methods of providing these services.

At present, it is estimated that all meter readings, billings and collections currently cost the utility companies a total of $14 to $18 per year per household.[12]

It is estimated that the current cost of manually reading all meters in a household (i.e., electric, gas and water meters) is about $6 per year. These costs are expected to double in the next five years because of increased labor costs. On the other hand, the estimated cost of automatically reading these meters via cable would be in the range of $8 to $10 per year per household and would not be expected to increase significantly in this time period.[13,14] Thus, by 1975, it is expected that the cost of manual reading would equal or exceed the cost of automatic reading via cable. In addition, there appear to be some further intangible benefits that should swing the balance in favor of automatic meter reading via cable by 1975. These include:

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[12] Martin, Richard, "Remote Meter Reading - The State of the Art," American Gas Journal, October 1969.

[13] Eldridge, F. R., "System for Automatic Reading of Utility Meters," The MITRE Corporation, M72-7, September 1, 1971.

[14] Eldridge, F. R., "Automatic Meter Reading Via Cable, The MITRE Corporation, M72-67, June 1972.

- Load Studies - Sensing switches could be used with the same system to determine whether the voltage or the gas or water pressures are within standard levels.
- Detection of Service Failures - Strategically located transducers could be placed in the system and polled after storms, earthquakes, etc. to determine where service outages exist.
- Continuous Operation - The automated system would be unattended and could operate on a 7-day per week basis. This would minimize overtime pay and reduce the effect of company holidays on the reading and billing cycle.
- Elimination of Skipped Readings - In the case of manual meter reading, many readings must be skipped each month because nobody is home to admit the meter reader. This problem would be eliminated with an automatic system.
- Reduced EDP - In manual meter reading, route books, marked cards or scrolls are used by the reader and, later, the data are converted to punch cards or magnetic tape for EDP billing and record keeping. The automatic reading process would eliminate the conversion step.
- No Weather Problems - Adverse weather conditions would not slow down or stop the automatic meter reading process as long as the cable lines are intact.
- Fewer Vehicles - Reductions in the number of vehicles required by the utilities would reduce expenses.
- Greater Safety - Damages to customer property and injuries to meter reading personnel from criminals, dogs, etc. would be eliminated.
- Minimized Personnel Problems - The annual turnover of meter reading personnel exceeds 100% in some utility companies. Automatic meter reading could reduce many ancillary costs, such as those for hiring, training, physical examinations and terminating personnel.

- Fixed Costs - An automated system should be relatively insensitive to inflationary trends, except in O&M charges.

- Increased Accuracy of Readings - Trials indicate an automatic meter reading accuracy of about 99.9% compared to 96% to 99% for manual. A high-low check is currently used to eliminate large errors and to keep monthly bills within 20% of the correct value for manual reading. This cost could be reduced or eliminated with automatic readings.

- Elimination of Estimated Bills - The necessity of estimating bills because of skips, reading errors, etc. would be eliminated with automatic systems.

- Reduction of Billing Requirements - Automatic reading would facilitate the possibility of joint billing by a service bureau type of organization, which would reduce billing costs and mail handling.

- Other Cost Savings - Automatic systems, including a remote shut-off valve, could result in savings of about $0.40 per meter per year by eliminating service calls for turn-on, non-pay turn-off and final turn-off services, as well as for re-reads and bill inquiry checks.

Furthermore, other utility services such as selective power load control via cable offer the possibility of a high economic leverage because of the possibilities for trading-off relatively large power generation and distribution equipment costs for the relatively low cost of providing communications systems for selectively controlling, on-line, the consumption of this power during peak load periods.[15] For instance, the Detroit Edison Company has invested about $10 million in capital equipment for a selective load control system that has reduced their requirements for capital investment in their generation and transmission plant by about $77 million. Such savings, if realizable in the Washington area, might be expected to produce a commercial demand for such services on the WCS. Plans for the WCS have, therefore, projected that, after a period of experimentation, some combination of utility and maintenance services, of the types indicated under Subsection 6 of Section III, would be provided by the system to all households in the District. It is expected that a reasonable level of fees to be paid by the utility and maintenance companies to the WCS for all such services might be about $2 per household per month if the utility and maintenance service companies can use the same type two-way subscriber response terminal that is supplied to a WCS subscriber for other subscriber response services.

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[15] Eldridge, F. R., "The Use of Cablecasting Systems for Control of Electric Power Grids," The MITRE Corporation, WP-7584, May 1971.

Electronic Information-Handling Services

As indicated in Table V-4, the only services covered in the Howard Survey of Washington, D. C. that could be provided by an Electronic Information-Handling System are those pertaining to educational courses and shopping, i.e., questions 5 and 7.

In addition, the surveys of demand for electronic information-handling services that have been made at Reston and Dayton cannot be expected to provide an accurate estimate of the demand for such services in Washington, since the sample of the population surveyed was not necessarily representative of Washington. Also, it should be noted, from a comparison of Figures V-3 and V-5, that while the estimate of penetration, for the case of the full complement of services, is quite similar in the two cases for low subscriber fees (i.e., in the $5 to $10 per month range), the results diverge considerably for higher monthly subscriber fees.

As a result of these uncertainties, the best estimates that can be given at this time of the demand for electronic information-handling services in Washington are that between 20% and 60% of the Washington households might be expected to subscribe to these services at an additional fee of from $15.50 to $8.50 per month. In other words, the subscribers to the Electronic Information-Handling System, i.e., 20% to 60% of the Washington households, might be expected to pay a total fee of between $22 and $15 per month for the full complement of services that could be offered by the Washington Cable System, including one-way services, two-way subscriber-response services and electronic information-handling services.

SECTION VI

FINANCIAL ANALYSES

This Section presents financial analyses of alternative approaches to the design, development, and funding of the Washington Cable System. In these analyses, the MITRE Economic Model* has been used to estimate the economic viability of alternative system implementation plans in which different types of cable services are introduced at different times during the course of the system implementation. These services include one-way services (i.e., with local and imported off-the-air TV signals, mechanical originations, and local cablecasting originations, and additional one-way services); two-way subscriber response services, including utility and maintenance services; two-way electronic information-handling services; special services; and point-to-point services.

Figure VI-1 is a block diagram of the procedure used in the computer model to conduct the economic analyses. Detailed data on capital expenditures, and operating and maintenance costs are used as inputs. Yearly revenues are obtained from subscriber fees, leased channels, advertising on the telecasting system, and special revenues from the point-to-point system, and for utility and maintenance services.

The computer program performs a yearly financial analysis, stores the results for each year in its memory (e.g., for loan repayment, tax

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*The MITRE Economic Model is a combination of a substantial modification of the accounting equations from the Comanor and Mitchell economic model (see p. V-3) and a totally new set of input and output formats.

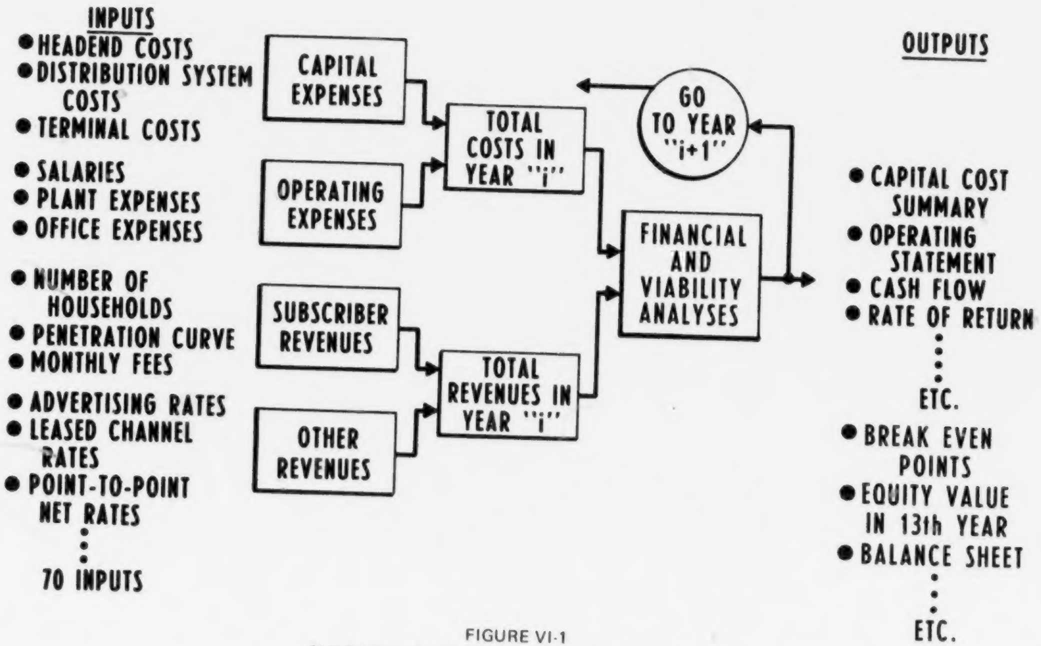

FIGURE VI-1
OVERVIEW OF FINANCIAL ANALYSIS PROCEDURE

carry-overs and debt-to-equity ratio requirements) and repeats the exercise for the first ten years. Capital expenditures, operating statements, cash flow statements and balance sheets are examples of the types of summary sheets which are produced. The year-by-year analysis addresses the time-phased plans for implementation of the system and adjusts the costs and revenues on a yearly basis to accurately reflect the changing financial characteristics of the system. The measures of economic viability that are used include: the ratio of operating expense-to-gross revenues, breakeven points for operating income, pre-tax profit and coverage of income tax, as well as minimum ratio of assets-to-outstanding debt, and the rate-of-return on equity and on total investment.

All systems analyzed in this Section would be city-wide systems under one franchise. The financial implications of multiple franchises are treated in Section VII.

The system design assumptions and the rationale for the cost and revenue assumptions used in these analyses are discussed in this Section and also in Sections III, V, and VII, and in Appendix B.

SYSTEM DESIGN ASSUMPTIONS

One-Way System

The economic analysis assumes that the initial financial commitments to the WCS could be made on the basis of a primarily one-way system of the type summarized in Table VI-1. Such a system would consist of two parallel telecasting cables, each running 1,074 miles

TABLE VI-1
SUMMARY OF BASIC ONE-WAY SYSTEM

- Two Parallel Telecasting Cables, Plus Four Point-to-Point Nets
- First Telecasting Cable, One-Way; 30 Channels, Fully Operational Throughout D.C.
- Second Telecasting Cable, Two-Way (Initially Quiescent Except in S/A 2 and 7); 30 Forward Channels plus 4 Reverse Channels, in S/As 2 and 7 only
- 100 Subscriber Response Terminals in Service Areas 2 and 7 in First Year, 1100 in Second Year, 6100 in Third Year
- Installation; 5 Phases of 1 Year Each
- Total Households Passed; 263,000
- 1222 Total Street Miles; 1074 Miles for Telecasting Net, Plus 148 Miles for Point-to-Point Nets
- Programming Costs, One-Way Services; $0.4 M/Year for Basic Programming Costs plus $9.50/Year/Subscriber for Other Programming Costs (see Sections III and VII)
- Final penetration, One-Way Services; 76% (see Section V)
- Subscriber Fees
    - All One-Way Services
        - Regular; $3.50 per Month per Subscriber
        - 2nd Set; $2.00 per Month per Subscriber
    - Experimental Subscriber Response Services in S/As 2 and 7
        - Regular; $3.00 per Month per Subscriber
- Rates for Other Services, 10th Year; a Total of $200/Min. for Advertising on 12 Channels; $20/Min./Channel for 12 Leased Telecasting Channels; and $4/Hour/Channel for 100 Leased Point-to-Point Channels.
- Revenues from Other Services; $9.28 per Year per Subscriber (i.e., the Equivalent of $3.65/Year/Subscriber from Advertising, $2.45/Year/Subscriber from 12 Leased Telecasting Channels, and $3.18/Year/Subscriber from 100 Leased Point-to-Point Channels).

and passing all of the 263,000 households in the District of Columbia, as well as all offices, businesses, and other potential subscribers.

Four special point-to-point nets would serve the Federal and Municipal Governments, educational institutions and some commercial organizations. The structure and layout of the telecasting net would conform to the nine Service Areas used by the D. C. Government for the provision of municipal services. Subscribers in each Service Area would be directly connected to either the master headend (i.e., Service Area 7) or to a subheadend and would also have access to origination facilities within their particular Service Area to permit the distribution of local programming within either individual Service Areas or combinations of Service Areas.

For this One-Way System, the first of the two parallel telecasting cables would carry up to 30 one-way video channels. A typical allocation of these channels to conventional one-way video services as well as additional one-way services, of the types indicated in Table V-7 is shown in Table IV-5.

Analyses for the initial financial commitments assume, furthermore, that the second of the two parallel telecasting cables would be initially quiescent, except in Service Areas 2 and 7 where it would be used, from the outset, for two-way experimentation and demonstrations of two-way services. Increments of 100, 1000 and 5000 response terminals would be provided to subscribers in these Service Areas in each of the first three years of system operation, respectively, at an additional charge of $3.00 per month per subscriber for the experimental services provided. The main purpose of these tests would be to determine how much the subscribers or other sponsors are willing to pay for the two-way subscriber response services that will be offered.

Subscriber Response (SR) System

A second system alternative has been examined that would add a capability to provide two-way subscriber response services, of the types shown in Table V-7, to all subscribers. This system alternative is summarized in Table VI-2. In analyzing this option, it is assumed that any decision to incorporate two-way subscriber response services throughout the system would be made before the fourth year, and, if this decision is made, that the retrofitting of two-way subscriber response terminals would be completed in the fourth year in Service Areas 2 through 7. In addition, two-way Subscriber Response terminals would be installed at initiation of service for all subscribers in S/A's 1 and 8 in the fourth year, in S/A 9 in the fifth year, and, for any new subscribers, in all S/A's, in subsequent years. Under this alternative full implementation of all subscriber response services would be completed by the end of the fifth year. A typical allocation of the thirty downstream plus four upstream channels of the second cable to additional one-way services as well as two-way subscriber response services in shown in Table IV-5.

TABLE VI-2
SUMMARY OF BASIC TWO-WAY SUBSCRIBER RESPONSE (SR) SYSTEM

Two Parallel Telecasting Cables, Plus Point-to-Point Nets

. First Telecasting Cable, One-Way; 30 Channels, Fully Operational Throughout D. C.

. Second Telecasting Cable, Two-Way; 30 Channels Downstream Plus Four Channels Upstream, Fully Operational Throughout D. C. After Third Year of System Operation

. 100 Subscriber Response Terminals in Service Areas 2 and 7 in First Year, 1100 in Second Year, 6100 in Third Year. Subscriber Response Terminals for All Subscribers After Third Year

. Installation; 5 Phases of One Year Each

. Total Households Passed; 263,000

. 1222 Total Street Miles; 1,074 Miles for Telecasting Net, Plus 148 Miles for Point-to-Point Nets

. Programming Costs, 1-Way and SR Services; $0.4M/Year for Basic Programming Costs, plus $25.25/Year/Subscriber for Other Programming Costs (see Sections III and VII)

. Final Penetration, 1-Way and SR Services; 78% (see Section V)

. Subscriber Fees

All One-Way Services plus All Two-Way Subscriber Response Services
Regular; $6.50 per Month per Subscriber
Second Set; $2.00 per Month per Subscriber

. Rate for Other Services, 10th Year; a Total of $200/Minute for Advertising on 32 Channels, $20/Hour/Channel for 32 Leased Telecasting Channels, $4/Hour/Channel for 100 Leased Point-to-Point Channels, and $2.00/Month/Customer for Utility and Maintenance Services

. Revenues from Other Services; $13.28 per Year per Subscriber (i.e., the Equivalent of $3.65/Year/Subscriber from Advertising, $6.55/Year/Subscriber from Leased Telecasting Channels, and $3.08/Year/Subscriber from Leased Point-to-Point Channels)

For a system implemented this year, this would assume that a sufficient number of two-way Subscriber Response Terminals (i.e., about 200,000) would be available by 1976 to supply all subscribers requesting these types of services. This may be optimistic, considering the amount of hardware and software that needs to be developed to implement the two-way Subscriber Response System by this time, unless the program is established in 1972.

Electronic Information-Handling (EIH) System

A third system alternative that has been examined would add a further capability, i.e., to provide electronic information handling services of the types shown in Table V-7. This basic system alternative is summarized in Table VI-3. The implementation phasing of services for the Electronic Information Handling System was assumed similar to that for the Subscriber Response System. This may also be optimistic, unless a firm decision is made to implement the system in 1972.

Since they are the best demand data available for Washington, D. C., the assumed final penetrations at the subscriber fees selected, for the three base cases described, have been based on the results of the Howard Marketing Survey (see Section V). These may prove to be optimistic, and emphasize the need for further demonstrations and market surveys (see Sections VII and VIII).

In addition, the financial analysis for each of the three basic system alternatives described above includes four separate 148-mile-long point-to-point nets to link many Federal and municipal facilities

TABLE VI-3
SUMMARY OF BASIC TWO-WAY ELECTRONIC INFORMATION HANDLING (EIH) SYSTEM

- Two Parallel Telecasting Cables, Plus Four Point-to-Point Nets
- First Telecasting Cable, One-Way; 30 Channels, Fully Operational Throughout D.C.
- Second Telecasting Cable, Two-Way; 30 Channels Downstream Plus Four Channels Upstream, Fully Operational Throughout D.C. After Third Year of System Operation
- 100 Combined Subscriber Response and Frame-Stopper Terminals in Service Areas 2 and 7 in First Year, 1100 in Second Year, 6100 in Third Year. Combined Terminals for 60% of Subscribers, and Subscriber Response Terminals for Remaining 40% of Subscribers, After Fourth Year (see Section V)
- Installation; 5 Phases of One Year Each
- Total Households Passed; 263,000
- 1222 Total Street Miles; 1074 Miles for Telecasting Net, Plus 148 Miles for Point-to-Point Nets
- Programming Costs, All Services; $6M for EIH Computer Programming plus $0.4M/Year for Basic Programming plus $45.25/Year/Subscriber for Other Programming (see Sections III and VII)
- Final Penetration, 1-Way and SR Services; 78% (see Section V)
- Final Penetration, EIH Services; 47% (see Section V)
- Subscriber Fees

  All One-Way Services, plus All Two-Way Subscriber Response Services, Only
    Regular; $6.50 per month per Subscriber
    Second Set; $2 per Month per Subscriber
  All Services
    Regular; $22 per Month per Subscriber
    Second Set; $2 per Month per Subscriber

- Rates for Other Services, 10th year; Same as for Basic Two-Way Subscriber Response System
- Revenues from Other Services: Same as for Basic Two-Way Subscriber Response System

(including all hospitals, fire stations, and police precincts), colleges and universities, a portion of the commercial establishments, and all of the District's public schools (see Table IV-8).

Construction of the telecasting and point-to-point nets, consisting of a total of 1222 street miles, is planned to occur concurrently in phases of one year each, as indicated in Figure IV-2.

SYSTEM COST ASSUMPTIONS

Cost inputs to the MITRE Economic Model consist of estimated capital expenditures for the system, broken out in terms of headend costs, distribution system costs, terminal costs, and other capital costs, as well as estimated operating expenses for the system in terms of salaries, plant expenditures, office expenses, programming costs, etc.

For the purposes of this analysis, unit capital costs of $27 were assumed for set-top converters used with the one-way services (see Appendix B). Maintenance costs for the One-Way System included 3% of capital costs for initial supplies of spare parts.

Unit capital costs for the terminals for the two-way Subscriber Response System were assumed to be $127 for new subscribers (see Appendix B), and $177 in cases in which retrofitting is required, i.e., for households in Service Areas 2 through 7 that subscribe during the first three years of system operations. These system costs are based on those for large-scale production of a simple Subscriber Response terminal with pushbutton keyboard and a coupler-decoder manufactured with large-scale integrated (LSI) circuitry. Maintenance costs for the Subscriber Response System include 3% of capital costs for initial supplies of spare parts.

A unit cost of $427 was assumed for the combined terminals for use with one-way services, subscriber response services, and electronic information-handling services. This is based on MITRE estimates of production costs for a combined terminal with full keyboard, a set-top converter, a coupler/decoder with privacy capabilities (see Appendix B), and a single-frame refresh unit to provide the frame-stopping functions required for EIH services. Maintenance costs for the EIH system included 6% of capital costs in the first year and 3% per year, thereafter, for spare parts and maintenance of terminals.

It has been assumed that all of these components would be manufactured with large-scale integrated circuitry. The above estimates are based on discussions with a number of equipment manufacturers (see Appendix B).

It was assumed that for the One-Way System there will be yearly programming costs of about $2.3 million by the 10th year for the two types of channels, shown in Table IV-5, that are assumed to require program origination for the first cable of the Washington Cable System. This includes $0.4M per year for basic programming, plus $9.50 per subscriber per year for other programming costs. Basic programming costs cover those for studio staff, employee benefits, and mobile studios. Other programming costs include costs of 10 hours a day of origination for two city-wide channels, at $80/hour/channel,[1] as well as $6.00 per subscriber for the cost of programming of new movies. The latter figure is based on data supplied by movie distributors,[2] and should provide for 20 to 30 new movies a year (see Section III).

The base case for the two-way Subscriber Response System assumes total yearly programming and software costs of about $6 million by the tenth year. This would be used to cover the six types of channels, shown in Table IV-5, that are assumed to require programming origination by the Washington Cable System. These costs include basic programming costs of $0.4M per year, plus $25.25 per subscriber per year for other programming costs. As in the One-Way System, the basic programming costs cover those for studio staff, employee benefits, and mobile studios. Other programming costs include those for the five city-wide channels indicated in Table IV-5 plus those for local origination in each of the nine Service Areas, at a cost of $80 per hour per channel for ten hours a day of programming, plus $6.00 per subscriber per year for new movies.

The base case for the two-way Electronic Information-Handling System assumes a total capital cost of $15M for 100 mini-computers, at $150K each, to provide EIH services throughout the District of Columbia and a total yearly programming and software cost of about

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[1] See Feldman, N., "Cable Television: Opportunities and Problems in Local Program Origination," R-570-FF, September, 1970.

[2] Forbes Magazine, "A Capital Game," March 1, 1972, page 33.

$10 million by the 10th year. These latter costs are the same as those for the Subscriber Response System, except $20 per year per subscriber has been added to cover the cost of basic software and new programming for the 100 EIH mini-computers. This is expected to cover all basic software required for all services shown in Table II-2, including a total of 68 new CAI courses in the 10-year period examined.

COST VERSUS CHANNEL CAPACITY

The normalized total capital cost of two-way distribution systems (including set-top converters, but no other terminal costs) versus the number of channels provided, for penetrations of 60% and 80% is shown in Figure VI-2. This figure and the text which follows have been adapted from Figure 3 of a Jansky and Bailey report,[3] and the accompanying text in that report. The twelve-channel system would use single-ended amplifiers. The 13-20 channel systems would use set-top converters at each home, as well as slightly reduced amplifier spacing, and single-ended amplifiers.

A capacity greater than 20 channels would require that the single-ended amplifiers be carefully designed and installed to minimize distortion, or that they be replaced with more costly push-pull amplifiers. The 31 to 60 channel systems would require that the second cable be activated. This naturally, would require additional

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[3] Engineering Report on the "Development of A Cable Television System for Washington, D. C.," Jansky and Bailey, June, 1971. Prepared under contract to this study.

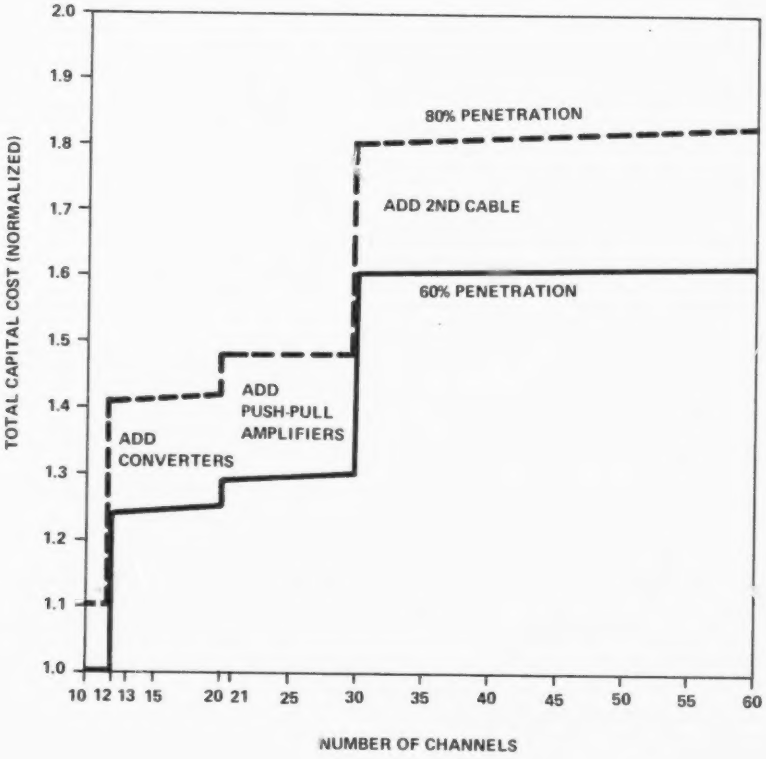

FIGURE VI-2
TOTAL CAPITAL COST FOR TWO-WAY DISTRIBUTION SYSTEM
(WITH SET-TOP CONVERTERS) VERSUS NUMBER OF CHANNELS PROVIDED

amplifiers and subscriber taps. All of these calculations of cost versus channel capacity requirements have assumed that a second, quiescent cable would be laid when the first cable is laid. At 31 channels and up, the second cable would need to be energized. No costs have been included in Figure VI-2 for any of the home terminals used for two-way subscriber response or electronic information-handling services.

SYSTEM REVENUE ASSUMPTIONS

The one-way base case system assumes a final penetration of 76 per cent (i.e., 205,000 subscribers in the tenth year of operation) for the first cable, with subscribers' fees of \$3.50 per month plus \$2.00 per month per additional TV set, and with 30% of the households subscribing for an additional TV set (see Section V). It is also assumed that all subscribers would be provided with FM radio service at no extra charge.

For the Subscriber Response (SR) System base case, it is assumed that additional one-way services, and two-way subscriber response services, as well as utility services will be available on the second cable at the beginning of the fourth system year, and will result in a penetration of 78% at subscriber fees of \$6.50 per month per subscriber for the one-way services, and subscriber response services provided by both cables, with a subscriber fee of \$2/month for additional TV sets in a household.

It is assumed that by the time the two-way Subscriber Response System is operational (i.e., the fourth year), the gas, water, and electric power utilities and/or maintenance service companies will start to pay a total of $2.00 per month per household for cable communications and central computer operations.* Data handling for utility and maintenance services discussed in Section III, including meter readings, selective load control, leak detection, load monitoring, and automatic billing, as well as maintenance of electrical equipment such as TV sets, converters, keyboards, amplifiers, etc. would be provided for this fee. It is assumed that in addition to the $2.00 per month per household, the utilities and maintenance companies would pay for the capital costs of meter reading units, control switches, voltage level switches and other special terminal devices associated with these utility and maintenance services, as well as for coupler/decoder units and cable connection charges for any utility or maintenance customers that do not subscribe to other telecasting services offered by the Washington Cable System. This is based on current costs and practices of the industry.

The base case for the Electronic Information-Handling (EIH) System assumes that, in addition to the services provided under the Subscriber Response System, electronic information-handling services will be available on the second cable at the beginning of the fourth system year, and will have a penetration of 47% at a subscriber fee of $22/month for all services offered (i.e., one-way services, two-way subscriber response services, and two-way electronic information-handling services). It is also assumed that those who do not subscribe to the electronic information-handling services would pay $6.50/month for the subscriber response services. Charges for additional sets and utility and maintenance services would also be the same as for the EIH system.

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*The sensitivity analyses in Section VII show the impact of other levels of revenues from this source.

By the tenth year, the projections for all three base cases also include additional annual revenues of $670,000 for the leasing of channels on the point-to-point nets, about $730,000 from advertising based on a total of $1.00 per minute per 1000 subscribers for ten minutes of advertising a day for all channels carrying cablecasting originations, and about $40,000 per year per leased telecasting channel based on $0.10 per hour per channel per 1000 subscribers from 5.6 hours per day of utilization for leased telecasting on either cable. The financial analysis in this Section also makes allowances for three free channels, one each for public access, educational purposes, and local government use.

A comparison of estimated leasing rates of video and voiceband channels required for the Washington Cable System and those derived from telephone company tariffs are given below:

LEASING RATES, PER MONTH, PER CHANNEL-MILE

	Video Channel
Washington Cable System	$ 36
Telephone Company	$ 80

The present rates for a video channel, leased from the telephone company are shown in Reference 4. The rates for the Washington Cable System's video channels have been estimated from the cost of a typical Washington Cable System channel with allowances for amortization, operating and maintenance expenses, taxes, and profit. These rate comparisons indicate that the telecasting system could offer almost a 50% reduction in telephone company rates, excluding the cost of any modems that might be required by the telephone company.

MEASURES OF ECONOMIC VIABILITY

In the financial analyses, using the MITRE Economic Model of the WCS, the economic viability of each system alternative has been determined by estimating total system costs and revenues for each year of system implementation and operation, and, from these, developing a financial operating statement, a summary of cash flow, and a balance

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[4] TV Communications, page 70, July 1971.

sheet showing system assets and liabilities for each year. Using these, estimates can be made of such measures of economic viability as:

- Total capital expenditures required
- Capital expenditures per household
- Capital expenditures per subscriber
- Gross revenues
- Gross revenues per subscriber per year
- Total operating expenses
- Operating expenses per subscriber per year
- The ratio of operating expenses to gross revenues
- Break-even point for operating income
- Break-even point for pretax profit
- Break-even point for coverage of interest payments by net income plus depreciation of capital equipment
- The minimum ratio of assets to outstanding debt as a function of time
- The market value of the system in the tenth year as derived either from operating income or some ascribed value per subscriber
- The rate-of-return on equity
- The rate-of-return on capital

For all cases analyzed in this Section, the market value in the tenth year was estimated to be seven times the operating income minus the outstanding debt plus the cash surplus for the system in that year. This is a rule-of-thumb commonly used by the cable industry.

The rate-of-return on equity has been computed for each system year of a given case. This computation is a function of the estimated market value, outstanding debt, cash-on-hand and annual stockholder equity payments. The relation of these factors is shown in the following equation:

$$EV_n = X_{n-1}(1+r) + X_{n-2}(1+r)^2 + \ldots + X_1(1+r)^{n-1}$$

where

EV_n - is the equity value which equals the estimated market value (seven times the nth year operating income) plus cash-on-hand minus outstanding debt in the nth year.

X_j - is the equity investment in the jth year

r - is the internal rate-of-return on equity.

The internal rate of return r, applied to investments X_j causes their cumulative compounded value to equal the final equity value EV_n.

The same type of procedure was used in computing rate-of-return on capital investment, except capital investment rather than paid-up equity was used in the above equation.

SUBSCRIBER RATES

One of the principal objectives of the financial analysis undertaken in this study was to determine the minimum possible subscriber rates that could be charged for services rendered while still attaining economic viability for the system, at least by the tenth year of operation. This section shows the methods used to determine these minimum possible subscriber rates. The results of the Howard University survey of the expected demand for the services provided by the system, as a function of prescribed subscriber rates (see Section V), as well as the estimates of system income from other types of revenues, were employed in this analysis. Other cities could be surveyed in a similar manner.

Several different cases were considered in the analysis, each based upon the data described in Section V, which were collected for MITRE by the School of Business and Public Administration of Howard University in a survey of 248 representative television-owning households in Washington, D. C. Table V-4 is a copy of the Howard University survey questionnaire.

The first case considered was based upon the cumulative dollar amounts for all of the eight one-way and two-way services surveyed (see questions 1 to 8) which were representative of dual, two-way cable system services. From the survey responses, a frequency distribution was prepared, which indicates the number of households that stated a willingness to pay a particular total monthly subscriber fee for the eight services. Figure V-2 is a graphic portrayal of this frequency distribution. From this distribution, the number of households willing to pay a given monthly rate or more was derived. The curve labelled "All One-Way plus All Two-Way Services" in Figure V-3 is a plot "fitted" to the monthly rates that potential subscribers stated they would pay, as a function of the portion of households (i.e., penetration level) willing to pay these rates or more.

From the curves in Figure V-3, it is a simple matter to project the annual subscriber revenue per households for Washington, D. C. The annual revenue per household from subscribers' fees is given by:

(12) x (average monthly fee per subscriber) x (% penetration)

Revenues, as a function of penetration, are shown on Figure VI-3 for various combinations of services. To obtain the total projected subscriber revenue, the revenue per household should be multiplied by 263,000, i.e., the number of households passed by the Washington Cable System telecasting net. Various penetration rates have been examined in this study to bound the range of possibilities. The higher bound has been based on an optimistic estimate of the effects of the planned large-scale demonstrations, the low subscribers fees, the experience that selected cable operators are having with their most popular one-way services, observation that systems with high ultimate penetrations experience fast growth rates and the results of the Howard University Survey (Section V).

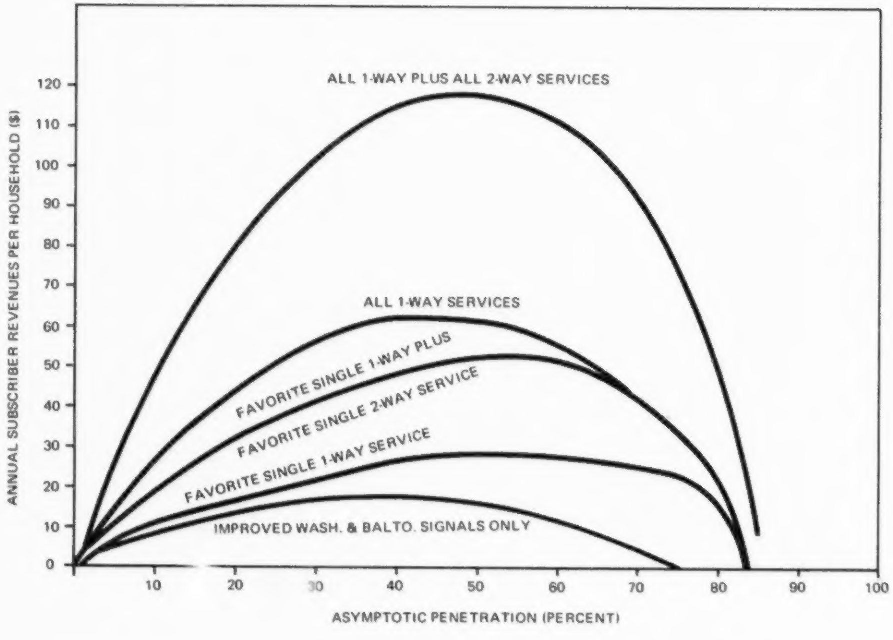

FIGURE VI-3
REVENUES AS A FUNCTION OF PENETRATION FOR
VARIOUS COMBINATIONS OF SERVICES

The MITRE computerized Economic Model (Figure VI-1) was used to perform a financial analysis of the phased implementation for several values of penetration using the corresponding monthly subscriber rate taken from Figure V-3. The base case for the One-Way System analyzed is described in Table VI-1.

The base case for the two-way Subscriber Response Systems analyzed is shown in Table VI-2 In this case, the subscriber rates used, during the first three years of system operation, for each level of penetration, were the total amounts that potential subscribers indicated a willingness to pay for the four one-way services (i.e., see questions 1 to 4). It was assumed that, starting with the fourth year of system operation, two-way subscriber response services (i.e., see questions 5 to 8) were added and the total acceptable rate for all eight services was used.

The other relationships between subscriber fees and expected penetrations (see Figure V-3) were analyzed in the same manner as indicated for the above case. Based on the results of these computer rules, an analysis of the projected profitability of a WCS system was performed as a function of system revenues and expenditures for several levels of penetration (recall that each level of penetration corresponds to a specific subscriber fee as shown in Figure V-3). All revenues and expenditures were normalized on a per household basis. Table VI-4 is a summary of these revenues and expenditures for penetrations of 30% to 80%. The last entry, "SURPLUS", was used

TABLE VI-4
PROJECTED 10TH YEAR WCS REVENUES AND EXPENDITURES FOR ALL ONE-WAY PLUS TWO-WAY SUBSCRIBER RESPONSE SERVICES

	PENETRATION					
	.30	.40	.50	.60	.70	.80
ANNUAL SUBSCRIBER COST (First Outlet)	$342.00	$282.00	$228.00	$180.00	$126.00	$72.00
REVENUE PER HOUSEHOLD						
a) Subscribers	104.77	115.70	117.60	112.30	93.24	63.36
b) Advertising and Leased Channels	3.27	3.76	4.22	4.53	4.95	5.37
c) Utility Services	24.00	24.00	24.00	24.00	24.00	24.00
TOTAL	$132.04	$143.46	$145.82	$140.83	$122.19	$92.73
EXPENDITURES PER HOUSEHOLD						
a) Operations, Interest and Depreciation	$ 34.86	$ 39.19	$ 43.76	$ 47.87	$ 51.71	$56.51
b) Taxes	46.50	49.92	48.86	44.52	33.71	18.61
c) Debt Retirement	0	.08	4.72	5.25	4.15	10.27
d) Capital Equipment	.65	.72	.80	.80	.80	.80
TOTAL	$ 82.01	$ 89.91	$ 98.14	$ 98.44	$ 90.37	$ 86.19
SURPLUS PER HOUSEHOLD (Total Revenue Less Total Expenditures)	$ 50.03	$ 53.55	$ 47.68	$ 42.39	$ 31.72	$ 6.54

as an indication of system profitability. It should be noted, however, that earlier years, in some cases, are less profitable than the tenth year, and that later years may be more or less profitable. In all cases considered, the first few years are found to be unprofitable while the system is being installed and its penetration is increasing.

It is also important to note that Table VI-4 is not a cash flow analysis, and actual cash surpluses may exceed the "SURPLUS" values given in this table. This difference is due primarily to the fact that depreciation expense is included, as shown in Table VI-4.

Several interesting relationships can be seen by plotting the data in Table VI-4 as well as similar data for the other cases described in Section V. Figures VI-4 through VI-7 are plots of total system revenue together with a plot of operating, interest, depreciation, and tax expenses plus expenditures for retirement of debt and capital equipment. The difference of the two curves is the "SURPLUS" and represents a first approximation to the system's economic viability. The range of maximum profitability is seen to lie in the region of 40% to 50% penetration. This result indicates that a system operated for profit and not having its subscriber fees constrained by franchise regulations, would be most viable when it serves no more than about half of the households in Washington, D. C. The curve also indicates that penetrations greater than about 70% or 80% could not be expected to be achieved, by a profitable system. Higher penetrations, therefore, would require some form of additional revenue or a subsidy. For

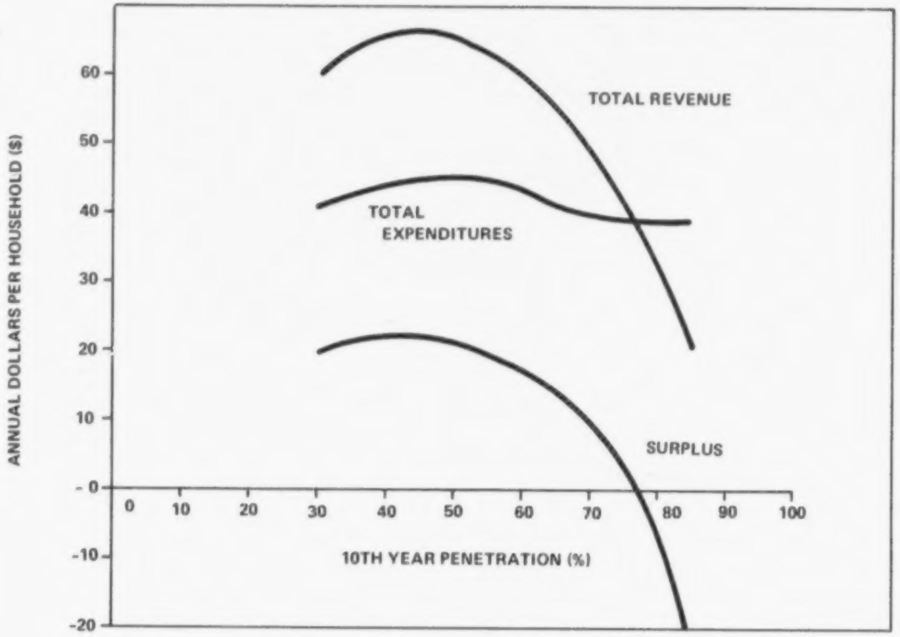

FIGURE VI-4
REVENUES, EXPENDITURES AND SURPLUS VS PENETRATION
FOR CASE OF ALL ONE-WAY SERVICES

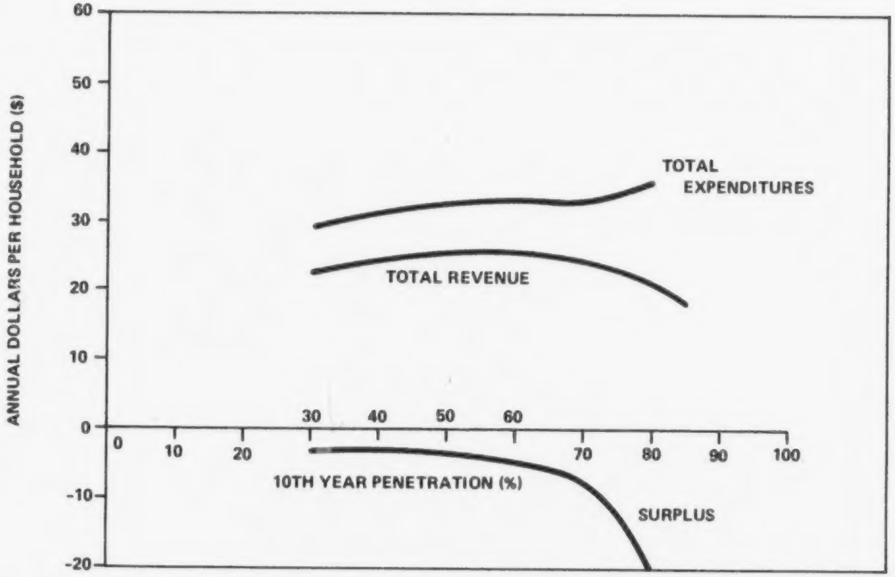

FIGURE VI-5
REVENUES, EXPENDITURES AND SURPLUS VS PENETRATION
FOR CASE OF FAVORITE SINGLE ONE-WAY SERVICE

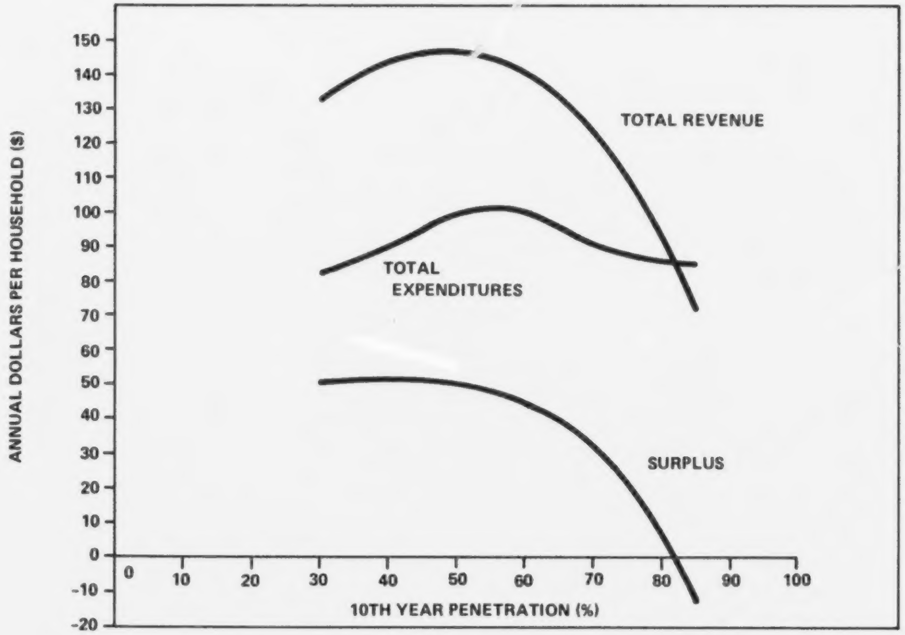

FIGURE VI-6
REVENUES, EXPENDITURES AND SURPLUS VS PENETRATION FOR CASE OF ALL ONE-WAY PLUS TWO-WAY SUBSCRIBER RESPONSE SERVICES

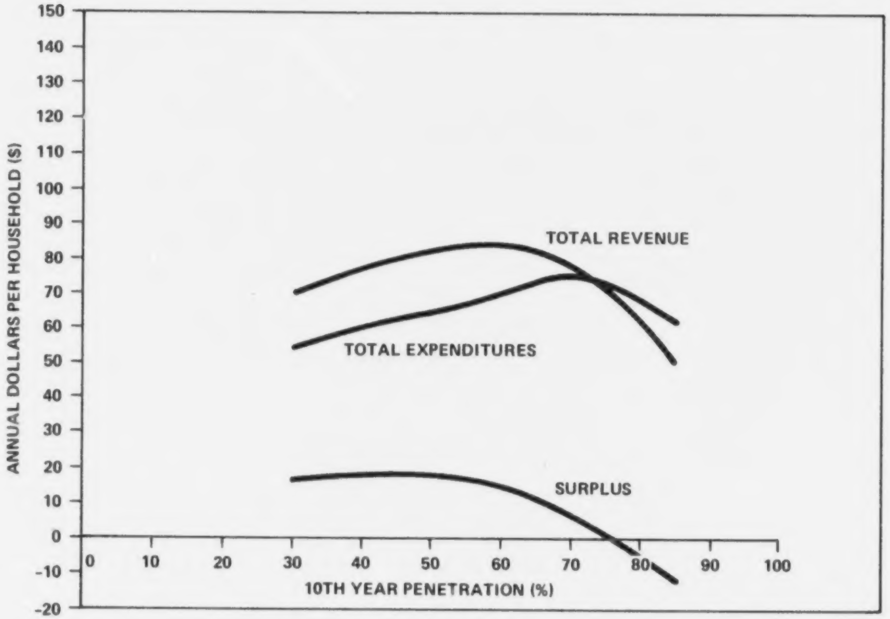

FIGURE VI-7
REVENUES, EXPENDITURE AND SURPLUS VS PENETRATION FOR CASE OF FAVORITE SINGLE ONE-WAY PLUS FAVORITE SINGLE TWO-WAY SUBSCRIBER RESPONSE SERVICE

this report, subscriber fees have been selected to maximize penetration while maintaining economic viability of the system.

Based on the Howard Survey, results shown in Figure V-3, a penetration of about 76% would be achieved for a subscriber fee of $3.50 per month for the one-way services provided by the first cable; about 78% penetration would be achieved with additional subscriber fees of $3.00 per month for the one-way services and subscriber response services provided by the second cable. Likewise, Figure V-3 shows that about 47% of the households might be expected to subscribe to all one-way and two-way services at a subscriber fee of $22 per month. Using this as an indicator, it has been assumed that, as a minimum, 47% of the households would subscribe to the services offered by the EIH System, and that an additional 31% (i.e., 78%-47%) would subscribe to the services offered by the two-way Subscriber Response System.

RESULTS OF FINANCIAL ANALYSES

Results of the financial analyses are shown in Tables VI-5 through VI-13 for the three alternatives in which the subscriber fees were minimized, as shown above, subject to the restraint of maintaining an economically viable system. These cases were selected on the basis of a city-wide system, under one franchise, with uniform subscriber fees, throughout the District of Columbia, for each of the three levels of service provided. For each case, aggregated sums for the five-system implementation phases are shown for the first ten years of system operation, in terms of capital expenditures, an operating statement and a cash flow statement.

TABLE VI-5
CAPITAL EXPENDITURES FOR THE ONE-WAY SYSTEM ($ MILLIONS)

YEAR:	1	2	3	4	5	6	7	8	9	10	TOTAL
CAPITAL EXPENDITURES	4.29	4.34	5.78	6.79	4.56	2.02	1.39	0.99	0.67	0.33	31.17
HEADEND	0.67	0.42	0.51	0.33	0.21	0.0	0.0	0.0	0.0	0.0	2.14
DISTRIBUTION	2.68	2.33	2.58	3.82	1.88	0.0	0.0	0.0	0.0	0.0	13.30
TERMINATION	0.90	1.54	2.64	2.58	2.42	2.02	1.39	0.99	0.67	0.33	15.48
OTHER	0.05	0.05	0.05	0.05	0.05	0.0	0.0	0.0	0.0	0.0	0.25

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TABLE VI-6
OPERATING STATEMENT FOR THE ONE-WAY SYSTEM ($ MILLIONS)

YEAR:	1	2	3	4	5	6	7	8	9	10	TOTAL
REVENUE	0.48	1.50	3.06	5.08	7.10	8.80	10.01	10.81	11.32	11.53	69.68
CABLECAST	0.42	1.29	2.63	4.35	6.06	7.50	8.52	9.20	9.62	9.80	59.38
OTHER (POINT-TO-POINT + ADVERTISING + LEASED CHANNELS)	0.06	0.21	0.43	0.73	1.04	1.30	1.49	1.62	1.70	1.74	10.31
OPERATING EXPENSES	1.26	2.03	3.14	4.28	5.13	5.78	6.21	6.46	6.63	6.72	47.65
OPERATING INCOME	-0.78	-0.54	-0.08	0.80	1.97	3.02	3.80	4.35	4.69	4.81	22.04
INTEREST	0.0	0.19	0.46	0.82	1.20	1.41	1.45	1.39	1.27	1.11	9.29
DEPRECIATION	0.29	0.58	0.96	1.41	1.72	1.85	1.94	2.01	2.06	2.08	14.89
PRETAX INCOME	-1.07	-1.30	-1.50	-1.44	-0.95	-0.25	0.41	0.95	1.37	1.63	-2.15
TAXES	0.0	0.0	0.0	0.0	0.0	0.00	0.29	0.40	0.77	1.03	2.50
INCOME AFTER TAXES	-1.07	-1.30	-1.50	-1.44	-0.95	-0.25	0.12	0.55	0.59	0.59	-4.64
EQUITY	2.85	1.77	1.89	2.16	1.22	0.0	0.0	0.0	0.0	0.0	9.89
LOANS	2.33	3.39	4.52	4.75	2.67	1.00	1.60	1.22	0.71	0.56	22.75
DEBT RETIREMENT	0.0	0.0	0.0	0.0	0.0	0.58	2.27	2.79	2.69	2.90	11.23
OUTSTANDING DEBT	2.33	5.72	10.24	14.99	17.66	18.08	17.41	15.84	13.87	11.52	
CAPITAL EXPENDITURES	4.29	4.34	5.78	6.79	4.56	2.02	1.39	0.99	0.67	0.33	31.17

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TABLE VI-7
CASH FLOW FOR THE ONE-WAY SYSTEM ($ MILLIONS)

YEAR:	1	2	3	4	5	6	7	8	9	10	TOTAL
REVENUES + EQUITY + CASH											
BEGINNING CASH	0.0	0.10	0.20	0.30	0.40	0.50	0.50	0.50	0.50	0.50	
REVENUE	0.48	1.50	3.06	5.08	7.10	8.80	10.01	10.81	11.32	11.53	69.68
CABLECAST	0.42	1.29	2.63	4.35	6.06	7.50	8.52	9.20	9.62	9.80	59.58
OTHER (POINT-TO-POINT + ADVERTISING + LEASED CHANNELS)	0.05	0.21	0.43	0.73	1.04	1.30	1.49	1.62	1.70	1.74	10.31
EQUITY	2.85	1.77	1.89	2.16	1.22	0.0	0.0	0.0	0.0	0.0	9.89
TOTAL REV.+EQ.+CASH	3.33	3.37	5.15	7.54	8.72	9.30	10.51	11.31	11.82	12.03	83.08
EXPENDITURES											
CAPITAL EXPENDITURES	4.28	4.34	5.78	6.79	4.56	2.02	1.39	0.88	0.67	0.33	31.17
OPERATING EXPENSES	1.28	2.03	3.14	4.28	5.14	5.78	6.21	6.44	6.63	6.72	47.65
INTEREST	0.0	0.19	0.46	0.92	1.20	1.41	1.45	1.35	1.27	1.11	9.29
TAXES	0.0	0.0	0.0	0.0	0.0	0.30	0.29	0.40	0.77	1.03	2.50
DEBT RETIREMENT	0.0	0.0	0.0	0.0	0.0	0.58	2.27	2.79	2.69	2.90	11.23
TOTAL EXPENDITURES	5.56	6.56	9.37	11.99	10.89	9.80	11.61	12.03	12.03	12.09	101.83
CASH SURPLUS	-2.23	-3.19	-4.22	-4.35	-2.17	-0.50	-1.10	-0.72	-0.21	-0.06	-21.75
LOANS	2.33	3.39	4.52	4.75	2.67	1.00	1.60	1.22	0.71	0.56	22.75
NET CASH SURPLUS	0.10	0.20	0.30	0.40	0.50	0.50	0.50	0.50	0.50	0.50	

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TABLE VI-8
CAPITAL EXPENDITURES FOR THE SUBSCRIBER RESPONSE SYSTEM ($ MILLIONS)

YEAR:	1	2	3	4	5	6	7	8	9	10	TOTAL
CAPITAL EXPENDITURES	5.31	5.22	7.11	26.43	11.63	2.07	1.42	1.01	0.68	0.33	61.22
HEADEND	0.67	0.42	0.51	0.33	0.21	0.0	0.0	0.0	0.0	0.0	2.14
DISTRIBUTION	3.67	3.17	3.36	5.67	2.45	0.0	0.0	0.0	0.0	0.0	18.82
TERMINATION	0.92	1.57	2.70	20.38	8.92	2.07	1.42	1.01	0.68	0.33	40.01
OTHER	0.05	0.05	0.05	0.05	0.05	0.0	0.0	0.0	0.0	0.0	0.25

1/31/72

TABLE VI-9
OPERATING STATEMENT FOR THE SUBSCRIBER RESPONSE SYSTEM ($ MILLIONS)

YEAR:	1	2	3	4	5	6	7	8	9	10	TOTAL
REVENUE	0.52	1.63	3.34	14.42	18.48	21.46	23.61	25.02	25.92	26.32	160.71
CABLECAST	0.43	1.33	2.69	13.33	16.92	19.51	21.37	22.59	23.37	23.71	145.24
OTHER (POINT-TO-POINT + ADVERTISING + LEASED CHANNELS)	0.09	0.31	0.65	1.09	1.56	1.95	2.24	2.43	2.55	2.61	15.47
OPERATING EXPENSES	1.41	2.45	3.96	6.36	7.99	9.19	10.05	10.56	10.93	11.08	73.99
OPERATING INCOME	-0.89	-0.82	-0.62	8.07	10.48	12.27	13.55	14.46	14.99	15.24	86.72
INTEREST	0.0	0.25	0.61	1.11	2.06	2.24	2.00	1.71	1.34	1.14	12.47
DEPRECIATION	0.35	0.70	1.18	2.94	3.71	3.85	3.95	4.01	4.06	4.08	28.83
PRETAX INCOME	-1.24	-1.77	-2.41	4.02	4.71	6.17	7.60	8.73	9.59	10.02	45.42
TAXES	0.0	0.0	0.0	0.57	1.90	3.11	3.73	3.99	4.54	4.84	22.68
INCOME AFTER TAXES	-1.24	-1.77	-2.41	3.45	2.80	3.06	3.87	4.75	5.05	5.18	22.74
EQUITY	3.15	1.95	2.15	8.25	3.25	0.0	0.0	0.0	0.0	0.0	18.74
LOANS	3.15	4.44	6.29	15.32	6.03	0.24	0.11	0.0	0.0	0.0	35.58
DEBT RETIREMENT	0.0	0.0	0.0	3.43	3.77	3.22	3.80	4.62	2.52	3.02	24.36
OUTSTANDING DEBT	3.15	7.59	13.88	25.77	28.04	25.05	21.37	16.75	14.23	11.22	
CAPITAL EXPENDITURES	5.31	5.22	7.11	26.43	11.63	2.07	1.42	1.01	0.68	0.33	61.22

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TABLE VI-10
CASH FLOW FOR THE SUBSCRIBER RESPONSE SYSTEM ($ MILLIONS)

YEAR:	1	2	3	4	5	6	7	8	9	10	TOTAL
REVENUES + EQUITY + CASH											
BEGINNING CASH	0.0	0.10	0.20	0.30	0.40	0.79	2.65	5.36	8.50	14.40	
REVENUE	0.52	1.63	3.34	14.42	18.48	21.46	23.61	25.02	25.92	26.32	160.71
CABLECAST	0.43	1.33	2.69	13.33	16.92	19.51	21.37	22.59	23.37	23.71	145.24
OTHER (POINT-TO-POINT + ADVERTISING + LEASED CHANNELS)	0.09	0.31	0.65	1.09	1.56	1.95	2.24	2.43	2.55	2.61	15.47
EQUITY	3.15	1.95	2.15	8.25	3.25	0.0	0.0	0.0	0.0	0.0	18.74
TOTAL REV.+EQ.+CASH	3.67	3.68	5.69	22.97	22.12	22.25	26.26	30.39	34.42	40.72	199.77
EXPENDITURES											
CAPITAL EXPENDITURES	5.31	5.22	7.11	26.43	11.63	2.07	1.42	1.01	0.68	0.33	61.22
OPERATING EXPENSES	1.41	2.45	3.96	6.36	7.99	9.19	10.05	10.56	10.93	11.09	73.99
INTEREST	0.0	0.25	0.61	1.11	2.06	2.24	2.00	1.71	1.34	1.14	12.47
TAXES	0.0	0.0	0.0	0.57	1.90	3.11	3.73	3.99	4.54	4.84	22.68
DEBT RETIREMENT	0.0	0.0	0.0	3.43	3.77	3.22	3.80	4.62	2.52	3.02	24.36
TOTAL EXPENDITURES	6.72	7.92	11.68	37.89	27.36	19.83	21.00	21.89	20.01	20.41	194.72
CASH SURPLUS	-3.05	-4.24	-5.99	-14.92	-5.24	2.42	5.25	8.50	14.40	20.31	5.05
LOANS	3.15	4.44	6.29	15.32	6.03	0.24	0.11	0.0	0.0	0.0	35.58
NET CASH SURPLUS	0.10	0.20	0.30	0.40	0.79	2.65	5.36	8.50	14.40	20.31	

1/31/72

TABLE VI-11
CAPITAL EXPENDITURES FOR THE ELCTRONIC INFORMATION HANDLING SYSTEM ($ MILLIONS)

YEAR:	1	2	3	4	5	6	7	8	9	10	TOTAL
CAPITAL EXPENDITURES	8.96	8.51	12.55	54.07	24.39	2.07	1.42	1.01	0.68	0.33	114.00
HEADEND	4.12	3.27	4.26	4.08	1.41	0.0	0.0	0.0	0.0	0.0	17.14
DISTRIBUTION	3.84	3.32	4.05	5.86	2.51	0.0	0.0	0.0	0.0	0.0	19.57
TERMINATION	0.95	1.87	4.20	44.08	20.42	2.07	1.42	1.01	0.68	0.33	77.04
OTHER	0.05	0.05	0.05	0.05	0.05	0.0	0.0	0.0	0.0	0.0	0.25

3/15/72

TABLE VI-12
OPERATING STATEMENT FOR THE ELECTRONIC INFORMATION HANDLING SYSTEM ($ MILLIONS)

YEAR:	1	2	3	4	5	6	7	8	9	10	TOTAL
REVENUE	0.52	1.63	3.34	24.03	32.16	38.61	43.28	46.36	48.33	49.22	287.49
CABLECAST	0.43	1.33	2.69	22.94	30.60	36.65	41.04	43.93	45.78	46.61	272.02
OTHER (POINT-TO-POINT + ADVERTISING + LEASED CHANNELS)	0.09	0.31	0.65	1.09	1.56	1.95	2.24	2.43	2.55	2.61	15.47
OPERATING EXPENSES	1.87	3.57	6.06	11.58	15.00	16.98	18.40	19.27	19.87	20.10	132.69
OPERATING INCOME	-1.35	-1.93	-2.72	12.46	17.16	21.62	24.88	27.09	28.47	29.12	154.80
INTEREST	0.0	0.42	1.02	1.99	4.04	4.88	4.70	4.42	3.92	3.66	29.04
DEPRECIATION	0.60	1.16	2.00	5.61	7.23	7.37	7.46	7.53	7.58	7.60	54.15
PRETAX INCOME	-1.95	-3.51	-5.74	4.86	5.88	9.38	12.71	15.14	16.97	17.86	71.61
TAXES	0.0	0.0	0.0	0.33	3.99	7.04	7.92	8.50	8.82	8.81	45.43
INCOME AFTER TAXES	-1.95	-3.51	-5.74	4.53	1.89	2.34	4.79	6.64	8.15	9.05	26.19
EQUITY	5.21	3.43	4.25	18.38	7.94	0.0	0.0	0.0	0.0	0.0	39.20
LOANS	21	7.53	12.13	34.13	16.21	1.25	0.85	0.39	0.16	0.0	77.86
DEBT RETIREMENT	.0	0.0	0.0	8.47	5.79	3.38	4.46	6.63	3.39	4.50	36.63
OUTSTANDING DEBT	5.21	12.74	24.87	50.52	60.94	58.81	55.20	48.95	45.73	41.23	
CAPITAL EXPENDITURES	8.96	8.51	12.55	54.07	24.39	2.07	1.42	1.01	0.68	0.33	114.00

3/15/72

TABLE VI-13
CASH FLOW FOR THE ELECTRONIC INFORMATION HANDLING SYSTEM ($ MILLIONS)

YEAR:	1	2	3	4	5	6	7	8	9	10	TOTAL
REVENUES + EQUITY + CASH											
BEGINNING CASH	0.0	0.10	0.20	0.30	0.40	3.48	8.98	16.20	23.12	34.94	
REVENUE	0.52	1.63	3.34	24.03	32.16	38.61	43.28	46.36	48.33	49.22	287.49
CABLECAST	0.43	1.33	2.69	22.94	30.60	36.65	41.04	43.93	45.78	46.61	272.02
OTHER (POINT-TO-POINT + ADVERTISING + LEASED CHANNELS)	0.09	0.31	0.65	1.09	1.56	1.95	2.24	2.43	2.55	2.61	15.47
EQUITY	5.21	3.43	4.25	18.38	7.94	0.0	0.0	0.0	0.0	0.0	39.20
TOTAL REV.+EQ.+CASH	5.72	5.16	7.79	42.71	40.49	42.08	52.27	62.56	71.45	84.16	373.45
EXPENDITURES											
CAPITAL EXPENDITURES	8.96	8.51	12.55	54.07	24.39	2.07	1.42	1.01	0.68	0.33	114.00
OPERATING EXPENSES	1.87	3.57	6.06	11.58	15.00	16.98	18.40	19.27	19.87	20.10	132.69
INTEREST	0.0	0.42	1.02	1.99	4.04	4.88	4.70	4.42	3.92	3.66	29.04
TAXES	0.0	0.0	0.0	0.33	3.99	7.04	7.92	8.50	8.82	8.81	45.43
DEBT RETIREMENT	0.0	0.0	0.0	8.47	5.79	3.38	4.46	6.63	3.39	4.50	36.63
TOTAL EXPENDITURES	10.83	12.49	19.62	76.44	53.22	34.35	35.91	39.83	36.68	37.40	357.78
CASH SURPLUS	-5.11	-7.33	-11.83	-33.73	-12.73	7.73	15.35	22.73	34.78	46.76	15.67
LOANS	5.21	7.53	12.13	34.13	16.21	1.25	0.85	0.39	0.16	0.0	77.86
NET CASH SURPLUS	0.10	0.20	0.30	0.40	3.48	8.98	16.20	23.12	34.94	46.76	

3/15/72

Capital expenditures are broken out in terms of those for headend facilities, the distribution net, system terminals, and other capital equipment.

The operating statements include:

- Revenues generated by subscriber fees for telecasting services, as well as revenues from advertising, and the leasing of channels on the point-to-point and telecasting nets
- Operating expenses, including plant expenses, office expense, and other expenses, such as those for programming functions and the FCC annual fee
- Operating income (i.e., the difference between revenues and operating expenses)
- Interest payments on loans
- Depreciation on plant and other capital equipment
- Pretax income (i.e., operating income minus interest payments and depreciation)
- Income taxes on pretax income
- Income after taxes (i.e., pretax income minus income taxes)
- Equity capital
- Loans
- Debt retirement
- Outstanding debt, and
- Capital expenditures

Cash flow statements, provided for each case, show:

- Cash balance at the beginning of each year
- Revenues
- Equity capital
- A total for revenues, equity and beginning cash balance
- Capital expenditures
- Operating expenses
- Interest payments on loans
- Income taxes on pre-tax income
- Debt retirement
- Total expenditures
- Cash surplus (i.e., revenues plus equity plus beginning cash balance minus total expenditures)
- Loans, and
- Net cash surplus (i.e., the difference between cash surplus and loans).

In all cases, a debt-to-equity ratio of about two-to-one, an interest rate of 8%, and a straight-line depreciation on capital equipment of fifteen years were assumed for the base case alternatives shown in this Section.

COMPARISON OF ALTERNATIVE SYSTEMS

Table VI-14 provides a summary comparison of the three base cases considered in this Section. Note that under the assumptions used for this analysis:

> Total capital expenditures required for the Electronic Information-Handling System (i.e., $114M) are almost twice those of the Subscriber Response System (i.e., $61M) which, in turn, are about twice those of the One-Way System (i.e., $31M). Capital expenditures per household, by the tenth year of system operation, are $119 per household for the One-Way System, $233 per household for the two-way Subscriber Response System, and $435 per household for the Electronic Information-Handling System. These costs for the one-way urban system are somewhat higher than the figure of $50 to $80 per household for conventional, 12-channel, one-way systems in smaller communities. These differences arise from more expensive plant equipment (primarily the set-top converters, dual cable plant, point-to-point net) required for the 30-channel one-way urban system, and the nine local studios for program origination, as well as higher installation and operating costs because of the underground construction and expensive duct rentals in urban areas, and because labor costs in Washington, D. C. are higher than the national average. These higher capital costs are offset, to some degree, by the high density of housing in the urban areas.

TABLE VI-14
SUMMARY COMPARISON OF THE BASE CASE SYSTEMS

SYSTEM CHARACTERISTICS	ONE-WAY SYSTEM	TWO-WAY SUBSCRIBER RESPONSE SYSTEM	TWO-WAY ELECTRONIC INFORMATION HANDLING SYSTEM
Number of Channels			
Telecasting			
Total	up to 30	up to 64	up to 64
Forward	up to 30	up to 60	up to 60
Reverse	6 (HA 2, 7 only)	4	4
Public Access	12	24	24
Imported TV and Cable Signals	5	6	6
Point-to-Point			
Total	150	150	150
Number of Two-Way Terminals			
Total (SR/Combined)			
1st Year	100/0	100/0	100/100
2nd Year	1,100/0	1,100/0	1,100/1,100
3rd Year	6,100/0	6,100/0	6,100/6,100
4th Year	6,100/0	85,668/0	85,668/51,401
5th Year	6,100/0	121,936/0	121,936/73,165
6th Year	6,100/0	152,824/0	152,024/91,694
7th Year	6,100/0	175,395/0	175,395/105,231
8th Year	6,100/0	190,218/0	190,218/114,131
9th Year	6,100/0	199,752/0	199,752/119,851
10th Year	6,100/0	204,124/0	204,124/112,474
Households Passed, 10th Year	262,796	262,796	262,796
Assumed No. of Subscribers, 10th Year	199,724	204,124	204,124
Final Penetration	76%	78%	78%/47%
Capital Expenditures, by 10th Year			
Total	$31.2M	$61.2M	$114.0M
Per Household	$119	$233	$435
Per Subscriber (Average)	$156	$299	$558
Operating Expenses, 10th Year			
Total	$6.72M	$11.1M	$20.1M
Per Household Per Year	$26	$42	$77
Per Subscriber Per Year	$36	$54	$99
Programming Costs			
Total, Ten Years	$15.0M	$34.3M	$58.5M
Per Subscriber Per Year	$9.50	$25.25	$45.25
Installation Fees (65% of Sub.)	$10.00	$10.00	[illegible]
Operating Fees			
1st Set, Final Fee	$3.50/Mo./Sub.	$6.50/Mo./Sub.	$22.00/Mo./Sub.
2nd Set	$2.00/Mo./Sub.	$2.00/Mo./Sub.	$ 2.00/Mo./Sub.
FM Radio	no charge	no charge	no charge
Rates for Leased Telecasting Channel	$20/Hr/Channel	$20/Hr/Channel	$20/Hr/Channel
Rates for Advertising	$200/Min/All Chan.	$200/Min/All Chan.	$200/Min/All Chan.
Rates for Utility and Maintenance Services	-	$2.00/Mo./Hld.	$2.00/Mo./Hld.
Rates for Leased Point-to-Point Channel	$4/Hr/Channel	$4/Hr/Channel	$4/Hr/Channel
Gross Revenues, 10th Year			
Total	$11.9M	$26.3M	$49.2M
Per Household Per Year	$44	$99	$187
Per Subscriber Per Year	$58	$128	$240
Equity Required (Debt/Equity = 2)	$ 9.9M	$18.7M	39.2M
Loans Required by 10th Year	$22.8M	$35.6M	77.9M
Interest Rate on Loans	8%	8%	8%
Ratio of Operating Expenses to Gross Revenues, 10th Year	0.58	0.42	0.41
Break-Even Points			
Operating Income	4th Year	4th Year	4th Year
Pre-Tax Profit	7th Year	4th Year	4th Year
Coverage of Interest Payments	6th Year	4th Year	4th Year
Minimum Ratio of System Assets-to-Outstanding Debts (min. Year)	1.19 (Year 6)	1.13 (Year 3)	1.07 (Year 3)
Estimated Value of System, by 10th Year	$22.7M	$115.8M	$242.6M
Rate-of-Return on Equity, 10th Year	11.9%	30.2%	28.4%
Rate-of-Return on Investment, 10th Year	0.0%	10.8%	10.3%

- By the tenth year of system operation, capital expenditures per subscriber, likewise, vary from $156 for the One-Way System, to $299 for the two-way Subscriber Response System, and to $588 for the Electronic Information-Handling System. It is interesting to note that the capital expenditures per subscriber for the Electronic Information-Handling System is comparable to the average capital expenditure per subscriber for the national switched telephone system (i.e., a pro rata cost of about $500 to $750 per telephone terminal). The analysis also shows that the One-Way Urban Cable System costs, per subscriber, compare favorably with 12-channel One-Way Cable Systems in smaller communities. A large part of the difference in the capital costs of the two-way systems versus the one-way systems is due to the unit cost of the subscriber terminal. For instance, for the One-Way System and the two-way Subscriber Response System, which had about the same assumed final penetrations, the difference in capital cost per subscriber was about $143. Of this about $100 is in the cost of the subscriber terminal.
- The total paid-in equity required for the Electronic Information-Handling System is about two times greater than that required for the Subscriber Response System, and about four times that of the One-Way System.

- By the tenth year, total operating expenses for both of the two-way systems could be almost twice as large as the One-Way System, and programming costs are more than twice as great for the Subscriber Response System and about four times as great for the EIH system.
- However, by the tenth year, total gross revenues for the Electronic Information-Handling System are almost twice as large as those for the Subscriber Response System, and almost five times as large as those for the One-Way System.
- By the tenth year, the ratio of operating expenses to gross revenues for the Electronic Information-Handling System is almost the same as that for the Subscriber Response System and both are only about 70% of that for the One-Way System. The two-way systems compare very favorably with current industry results where the band of experience is in the range of 0.50 to 0.60.
- Break-even points for the two-way systems in terms of operating income and pretax profits, as well as coverage of interest payments by net income and depreciation, are somewhat better than for the One-Way System.
- For all cases considered, the minimum ratio of system assets to outstanding debts varies between 1.07 and 1.19 and reaches this minimum value in earlier years for the two-way cases than for the one-way case.

- By the tenth year, the estimated market value for the Electronic Information Handling System is over two times as great as that for the Subscriber Response System, and over 10 times as great as for the One-Way System.
- Finally, the estimated rates-of-return on paid-in equity is significantly higher for both of the two-way systems than for the One-Way System. Also note that the rate-of-return on investment is close to zero in the tenth year for the one-way case, but is 10% to 11% for the two-way cases in that year.

Figures VI-8 and VI-9 show the rate-of-return on equity and investment, as a function of system year, for the three base cases presented in this Section. In general, it is seen that the rate-of-return on equity peaks out sooner and at higher values for the two-way systems than for the One-Way System.

In summary, MITRE, under the conditions assumed, the two-way cable communications systems that provide higher levels of services than the One-Way System will also provide higher internal rates-of-return on both equity and the total capital investment needed for these systems.

It is clear that the Electronic Information-Handling System, that has been described and analyzed above, would require a major

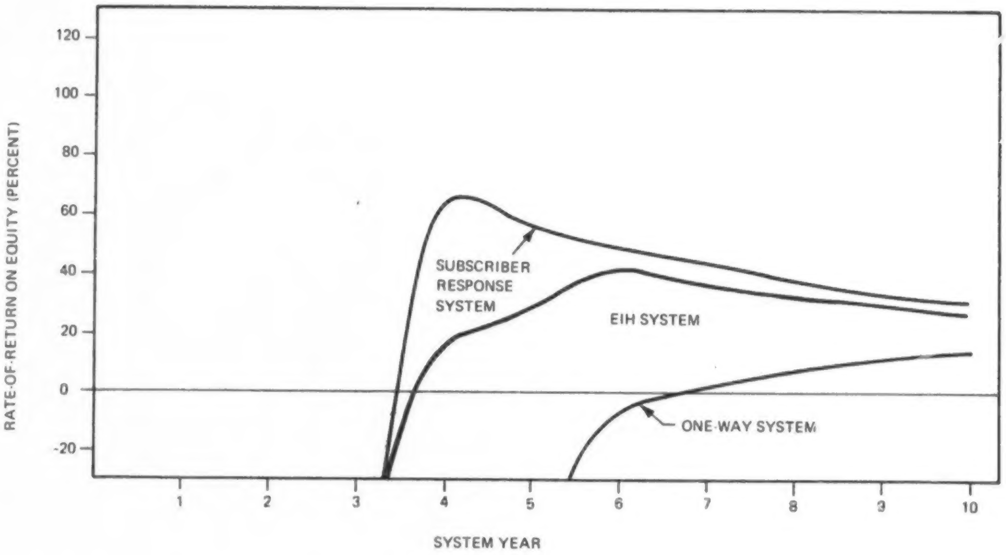

FIGURE VI-8
COMPARISON OF INTERNAL RATE-OF-RETURN ON EQUITY
FOR THREE BASE CASE SYSTEMS

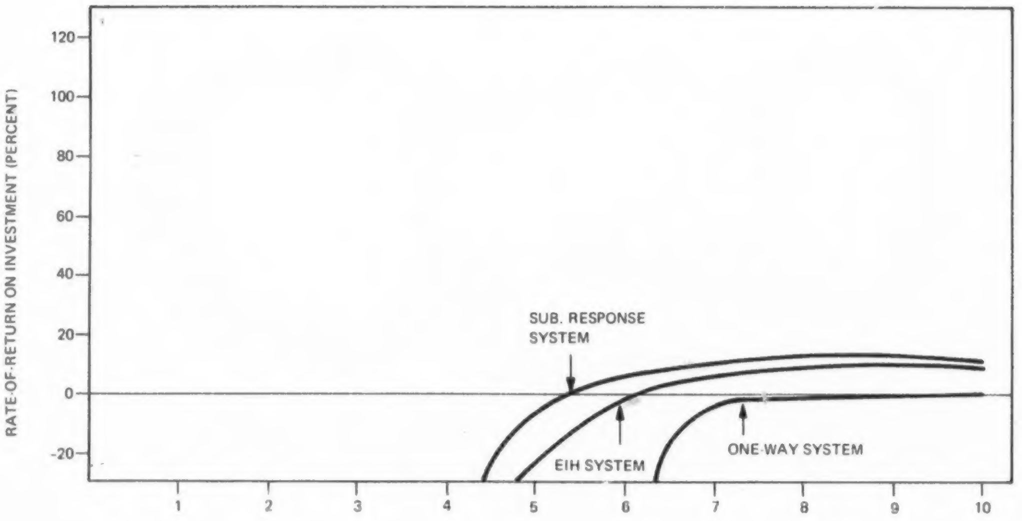

FIGURE VI-9
COMPARISON OF INTERNAL RATE-OF-RETURN ON INVESTMENT
FOR THREE BASE CASE SYSTEMS

investment in plant and equipment--somewhat comparable to the present investment in telephone plant and equipment in each area served. However, the benefits from this investment in terms of new services provided, trade-offs of old services for these new services, and improved quality-of-life, not only in urban areas but throughout the nation, could be of major significance.

Further demonstrations and market surveys of these new wideband cable communications services appear to be needed to resolve, as soon as possible, some of the marketing uncertainties that exist, and to clarify some of the technical, organization, financial and policy problems associated with the implementation of such new wideband cable communication services.

The next Section explores some of these uncertainties and their possible impact on these conclusions.

SECTION VII

SENSITIVITY ANALYSES

INTRODUCTION

This Section summarizes the sensitivity analyses performed in connection with the financial analyses presented in Section VI. Here we examine the effects of financial parameters such as interest rates, system parameters such as subscriber terminal costs, and organizational parameters such as number of franchises. Starting with each of the three base cases examined in Section VI, a variety of the input parameters have been varied, individually, over a discrete set of values. These "new cases" were then rerun using the MITRE Economic Model. The parameters that were varied, the range of variations examined, and the measures of sensitivity used in these analyses are discussed below.

FINANCIAL FACTORS

Debt-to-Equity Ratio

Runs were made at debt-to-equity ratios of 1:1 and 5:1 for the base case for One-Way Systems, and for the base case for two-way Subscriber Response Systems, whereas the debt-to-equity ratio used for all three base cases in Section VI was 2:1.

Interest Rates

Runs were made at interest rates of 6% and 10% for the One-Way System and the two-way Subscriber Response System whereas the interest rate on loans was 8% for all three base cases in Section VI.

SYSTEM DESIGN FACTORS

Growth Curve

Three different growth curves (i.e., fast, medium, and slow) have been used in these analyses. These represent the growth in penetration, by year, in terms of percentage of final penetration of the systems in each sector. The three growth curves that have been assumed are shown below:

PERCENTAGE OF FINAL PENETRATION

Type of Growth	System Year 1	2	3	4	5	6	7	8	9	10
Fast	70%	91%	97%	100%	100%	100%	100%	100%	100%	100%
Medium (Base Cases)	30%	50%	70%	80%	90%	100%	100%	100%	100%	100%
Slow	25%	45%	70%	82%	88%	91%	94%	95%	96%	97%

The "Fast" growth curve is somewhat similar to that used in the RAND Study of Dayton,[1] while the "Slow" growth curve is the same as that developed by Comanor and Mitchell, based on their study of a number of existing CATV Systems.[2]

The "Medium" growth curve, which assumes that final penetration is reached by the sixth year, was used for the three base cases shown in Section VI. The results of runs using the fast and slow growth curves for the One-Way and Subscriber Response cases are presented in this Section.

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[1] "Cable Communication in the Dayton Miami Valley", The RAND Corporation, January 1972.

[2] Comanor, W. S. and Mitchell, B. M., "Economic Consequences of Proposed FCC Regulations on the CATV Industry", Stanford University, December 1970.

Underground Construction Costs

Two types of composite underground construction cost categories were used in Section VI, i.e., those for areas in which no aerial cable is permitted, and those for areas in which aerial construction is permitted in alleys only. The composite cost per mile of underground construction for these two categories was assumed to be as follows:

Category	Composite Cost
Underground construction only	
Laying of cable	$14,600 per mile
Duct construction	$37,175 per mile
Aerial construction in alleys only	
Laying of cable	$ 9,536 per mile
Duct construction	$24,236 per mile

The above constitutes the "medium" case for underground construction costs. In the "high" case, used in this section, these costs have been doubled and in the "low" case they have been reduced by one-half.

Studio Costs

The base cases, examined in Section VI, assumed that one master studio would be built at a capital cost of $100,000 and eight local studios at $50,000 each. Analyses have been made for the One-Way and Subscriber Response Systems to determine the financial impact of raising these capital costs to $300,000 for the master studio and $100,000 for each local studio, in one set of cases, and to $1 million for the master studio and $500,000 for each local studio in another set.

Other Programming Costs

For all cases presented in this report, it has been assumed that there would be a basic ten-year O&M cost of $3.8 million for staffing and operating the master and local studios. (See Tables VI-1 to VI-3). These costs have been included under the category of programming. In addition, the base case for the One-Way Systems allowed $3.50 per year per subscriber for locally originated programming on one channel, and $6.00 per year per subscriber for new movies, whereas the base case for the Subscriber Response Systems allowed $19.25 per year per subscriber for the locally originated programming on six channels, and $6.00 per year per subscriber for new movies. The base case for the Electronic Information-Handling System allowed $19.25 per year per subscriber for the six channels of locally originated programming, $6.00 per year per subscriber for new movies and $20.00 per year per subscriber for programming of the EIH computer for a total of $45.25 per year per subscriber. For the One-Way Systems, variations have been examined which allow $0, $3.50 and $15.50 per year per subscriber for these and other programming costs. Likewise, for the Subscriber

Response System, variations have been examined which allow $0, $10.25 and $31.25 per year per subscriber for these and other programming costs. For the Electronic Information-Handling System a variation at $35.25 per year per subscriber was also considered.

Operating and Maintenance Costs

For the base cases the assumed operating and maintenance costs were about 15% of the capital cost per year for the One-Way System, about 10% per year for the Subscriber Response System and about 8% per year for the Electronic Information-Handling System which includes, in the latter case, an increment of 3% per year for spare parts and maintenance. Variations included cases where the O&M costs for the EIH system were lowered to 5% of capital costs per year and raised to 11% and 14% per year of these costs.

Subscriber Response Terminal, Capital Costs

The base case for Subscriber Response Systems presented in Section VI assumes that the capital costs of a subscriber response terminal would be $127 (see Appendix B), including the cost of a set-top converter (i.e., $27) of the type included in the basic One-Way System. In the base case, for Subscriber Response Systems, an extra $50 for each subscriber response terminal was included for those terminals that would have to be retrofitted. These subscriber response terminals would reflect new technology and the results of two-way experimentation that would be completed by the time of retrofit (i.e., the fourth year of operation). In this Section, runs have been made to show the impact of eliminating the retrofitting cost. This would allow only $127 for the capital cost of each subscriber response terminal. In another variation, $277 was allowed for the capital cost of each subscriber response terminal. The latter is a representative cost of a subscriber response terminal incorporating a strip printer (see Appendix B).

Electronic Information-Handling (EIH) Terminal, Capital Costs

The base case for Electronic Information-Handling Systems assumes that the capital cost of EIH terminals will be $427 per subscriber (see Appendix B). This includes the cost of the terminal equipment needed to perform the function of the set-top converter and the subscriber response terminal, as well as the functions of frame-stopping and private mode operations.* Variations assumed that these capital costs would be as low as $327 per subscriber, or as high as $627 per subscriber. The former costs might be representative of single frame-stopper terminals using chip technology, and the latter of multi-frame stopper systems using video tape recorders.

Installation Fee

All base cases assumed that 65% of the subscribers would pay $10 for installation of the terminals used in their homes. This Section presents the results of two variations assuming that as a result of promotional campaigns either 65% of the subscribers would pay only an average of $5 for installation, or that no charge would be made for installation.

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*In addition, the base case for EIH includes a headend capital cost of $15M for one hundred new computers at $150,000 each.

Penetration vs. Subscriber Fee

The results of the demand analyses for cable services presented in Section V showed that, for the ranges of interest, a rapid change in penetration could be expected as the subscriber fee was varied. The demand curves shown in Figure V-3 have been used, therefore, in selecting the expected penetration for each level of service and the corresponding subscriber fees that were used in the runs made for this study. These combinations of fees and demand are critical to the analyses, and yet, because of the small sample size used in the survey, they are one of the most uncertain assumptions used. Therefore, a large range of combinations of fees and resulting penetrations have been used in the study to determine their possible impact on the results presented.

For the base One-Way System in Section VI, it was assumed that a final penetration of 76% would be achieved at a subscriber fee of $3.50 per month for the level of One-Way services assumed (see Table II-5 and Figure V-3). Variations on this base case assume 75% final penetration at a subscriber fee of $5 per month, and 50% final penetration at $5 per month. The former combination of fees and penetration was selected on the basis of the demand curve in Figure V-3 that is labelled "All One-Way Services", and the latter combination on the basis of the curve labelled "Favorite Single One-Way Service". This, it was felt, would cover the range of uncertainty that exists, since potential subscribers might be expected to pay at least as much for all of the one-way services, provided by the system, as they indicated they would pay for their favorite single service.

Likewise, the base case for Subscriber Response Systems assumed 78% for final penetration at $6.50 per month per subscriber, and variations examined assumed 75% for final penetration at a subscriber fee of $8 per month, and 50% at $8 per month. These values were selected from the demand curves of Figure V-3 using the same procedure as indicated above for the One-Way Systems.

The base case for EIH Systems assumed that 78% of the households would subscribe to at least one level of service. Based on the demand analyses presented in Section V,[3] it was assumed that, of the 78% that did subscribe, about three-fifths would subscribe to all services offered at $22 per month, and the remaining two-fifths would subscribe only to the subscriber response services offered at $6.50 per month. Variations used in the sensitivity analysis assumed 37% penetration for all services at $26 per month, 53% at $18 per month, and 60% at

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[3] The Howard Survey did not explicitly cover all electronic information-handling services that would be provided by the EIH Systems, and the Reston/Dayton results are probably not representative of Washington, D. C. Therefore, the "all services" results shown in Figure IV-3 were used for the EIH Systems analyses on the assumption that they would represent the minimum expected penetration of EIH System services for the associated subscriber fees.

$15 per month. The above ratio of EIH to SR subscribers of course, changes for each of these variations.

Leased Channel Rates, Telecasting Net

As indicated in Section VI, the rates used for leased channels on the telecasting nets for the base cases was $0.10 per hour per channel per 1000 subscribers. Since all of the base cases assumed about 200,000 subscribers by the tenth year of system operation, the above leased channel rate is equivalent to about $20 per hour per channel by the tenth year. MITRE's estimates (shown in Appendix B) indicate that these charges would be less than one-half the pro rata cost of supplying this type of service. Variations examined included no-charge for leased telecasting channels, as well as charges of $50 per hour per channel, and $100 per hour per channel. These latter charges are more in line with those needed to produce economic viability for the leased telecasting channel operations per se. In other words, the base cases assumed some subsidization of leased channel operations by other users of the system, in order to promite the use of these leased channels.

Leased Channel Rates, Point-to-Point Net

The rates used for leased channels in the base cases were $4 per hour per channel. This allows for both annual O&M costs at about 10% of the total capital costs of the Point-to-Point Nets, and amortization of the total capital costs of these nets, assuming 8% interest on capital and a 10-year depreciation. It does not allow for either taxes or profit on these operations. Only on this basis, would the revenues generated be sufficient to make the leased point-to-point channel operations economically viable. Variations examined included no charge for leased point-to-point channels, as well as charges of $2 per hour per channel, and $6 per hour per channel.

Advertising Rates

The base cases, presented in Section VI, assumed an advertising rate of $1 per minute per 1000 subscribers,[4] or $200 per minute for ten minutes of advertising a day, inserted on all cablecasting channels that would carry advertising (i.e., about twelve channels for the one-way systems and thirty-two channels for the two-way systems). This was based on the equivalent advertising rate for one network TV channel.[5] In other words, it was assumed in the base cases that all cablecasting channels would generate about the same advertising revenues as one network TV channel. Variations examined included cases where it was assumed no advertising revenues would be generated by the cablecasting channels, and, where it was assumed that these channels would generate advertising revenues, at a rate of $400 per minute for ten minutes of advertising a day, inserted on all cablecasting channels that would carry advertising.

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[4] Peters, R. W., "Economics of Origination: Anticipating Tomorrow", TV Communications, December 1971.

[5] "BBDO Audience Coverage and Cost Guide", Stanford Research Institute, 1969.

Rates for Utility and Maintenance Services

The base cases for the two-way systems examined in Section VI assumed that $2 per month per household would be collected from utility and maintenance companies for communications and computer services provided by the telecasting net (see Section III). Variations on the Subscriber Response System include cases where no revenues are collected from utility and maintenance companies, and cases where a total of $3 per month per household would be collected for these services.

Market Value

In estimating the market value of the base case systems, it was assumed that this value would be seven times the operating income in any given year, plus the cash surplus in that year, minus the outstanding debt in that year. Variations examined used the same formula as above, but used an operating income multiplier of five times the operating income and ten times the operating income.

ORGANIZATIONAL FACTORS

For the base cases presented in Section VI, it was assumed that each system examined would be a city-wide system under a single franchise. Variations examined included alternatives under which five separate franchises were awarded for Washington cable systems according to the following aggregations of service areas (see Figure II-1):

Sector[6]	Service Areas
1	2 and 7
2	5 and 6
3	3 and 4
4	1 and 8
5	9

Under the multiple franchises option, each sector has been assumed to have:

1 major mobile studio	$128K
1 small mobile studio	$ 76K
2 master studios @ $300K	$600K

For the base cases, one major mobile studio and two small mobile studios were included in the city-wide system under a single franchise.

For the multi-franchise situation where only one-way services are provided we have examined the effects of providing 1000 polling terminals in each Sector, at the time of system initiation, for experimental and demonstration purposes. Subscriber fees would be collected for these services in order to measure the willingness of subscribers to pay for the levels of services offered. For the multi-franchise situation with two-way systems, it has been assumed that appropriate terminals would be installed in each Sector at the time of system initiation.

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[6] The multiple franchising variates have assumed geographical coverage based on the existing Service Area boundaries. Service area boundaries have been used because of the relative ease in deriving demographic data. Clearly, at the time of franchising other geographical boundaries could be considered.

For all the cases of multiple franchising, it was assumed that each Sector would have a headend, for handling local off-the-air signals, but that all Sectors would share the cost of imported signals.

Variations on the base case for one-way systems examined:

(1) The base case for One-Way Systems, but with five separate franchises.

(2) The base case for One-Way Systems, but with five separate franchises, and with 75% final penetration at $5.00 per month per subscriber.

(3) The base case for One-Way Systems, but with five separate franchises, and with 50% final penetration at $5.00 per month per subscriber.

(4) The base case for One-Way Systems, but with five separate franchises, and with subscriber fees proportional to the capital costs of each Sector. This results in fees as follows:

Sector	Subscriber Fees
1	$3.50/month
2	$3.50/month
3	$3.25/month
4	$3.45/month
5	$4.70/month

Variations on the base case for the Subscriber Response System examined:

(1) The base case for Subscriber Response Systems, but with five separate franchises.

(2) The base case for Subscriber Response Systems, five separate franchises, and 75% penetration at $8 per month.

(3) The base case for Subscriber Response Systems, five separate franchises, and 50% final penetration at $8 per month per subscriber.

(4) The base case for Subscriber Response Systems, five separate franchises, and subscriber fees proportional to the capital cost of each sector. This resulted in fees as follows:

Sector	Subscriber Fees
1	$6.25/month
2	$6.45/month
3	$6.25/month
4	$6.55/month
5	$7.85/month

Variations on the base case for the Electronics Information-Handling Systems examined:

(1) The base case for Electronic Information-Handling Systems, but with five separate franchises.

(2) The base case for Electronic Information-Handling Systems, five separate franchises, and both subscriber response and one-way services penetrating at 75% at $8 per month.

(3) The base case for Electronic Information-Handling Systems, five separate franchises, and both subscriber response and one-way services penetrating at 50% at $8 per month.

The values of the above parameters that were used in each of the base cases, as well as in the variations examined, are summarized in Tables VII-1 through VII-6.

MEASURES OF SENSITIVITY

The impact of above variations were measured in terms of their effects on equity, loans, capital expenditures, etc. as shown across the top of Tables VII-2, VII-4, and VII-6.

A description of the measures selected for these summary comparisons is given below.

Equity Required - This is the total amount of paid-in equity required, through the tenth year of system operation, to maintain the debt-to-equity ratio indicated.

Loans Required - This is the total for the amount of loans required, through the tenth year of system operation, to maintain the debt-to-equity ratio indicated.

Capital Expenditures - This is the total capital expenditure required for the system, through the tenth year of systems operation.

Equity Plus Loans/Capital Expenditures - This ratio, computed for the ten year period, is of significance since, if it is greater than 1.00 it indicates that the system's operating expenses plus interest on loans, plus taxes, plus debt retirement plus net cash, would have

TABLE VII-1
BASIC VALUES FOR PARAMETERS USED IN BASE CASE FOR ONE-WAY SYSTEMS

FINANCIAL PARAMETER	BASIC VALUE
Debt:Equity	2:1
Interest Rate	8%
SYSTEM PARAMETERS	
Growth Curve	Medium
Underground Construction Costs	Medium
Studio Costs	$100K/$50K
Other Programming Costs	$9.50/Yr./Sub.
Installation Fee, 65% of Subscribers	$10/Sub.
Penetration at Subscriber Fee	76% at $3.50/Mo./Sub.
Leased Channel Rates, 10th year	
Telecasting, 12 Channels	$20/Hr./Channel
Point-to-Point, 100 channels	$4/Hr./Channel
Advertising Rates, Incl. All Cablecasting Channels, 10th Year	$200/Min.
Market Value	7 X Oper. Income
ORGANIZATIONAL STRUCTURE	
Number of Franchises	1

TABLE VII-2
SENSITIVITY ANALYSIS
ONE-WAY SYSTEMS

	[illegible]	[illegible]	CAPITAL EXPENDITURES	[illegible]	OPERATING EXPENSES, YR. 10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BASE CASE:												
ONE-WAY SYSTEM (CITY WIDE)	$9.9M	$22.3M	$31.2M	1.03	$6.7M	$11.5M	0.58	$22.6M	11.4%	$0.6M	$15.0M	0.03
FINANCIAL VARIATIONS												
DEBT/EQUITY												
1:1	$14.3M	$16.9M	$31.2M	1.00	$6.7M	$11.5M	0.58	$29.1M	10.5%	$1.5M	$15.0M	0.04
3:1	$ 5.2M	$25.6M	$31.2M	1.11	$6.7M	$11.6M	0.58	$16.5M	16.7%	$0.2M	$15.1M	0.03
INTEREST RATE												
8%	$ 9.5M	$21.2M	$31.2M	0.98	$6.7M	$11.5M	0.58	$24.2M	13.5%	$0.5M	$15.0M	0.03
10%	$10.3M	$24.2M	$31.2M	1.11	$6.7M	$11.5M	0.58	$21.0M	10.1%	$0.5M	$15.0M	0.03
SYSTEM VARIATIONS												
GROWTH CURVE												
FAST	$ 9.1M	$17.2M	$31.2M	0.86	$6.7M	$11.6M	0.58	$31.5M	18.1%	$2.5M	$17.2M	0.14
SLOW	$10.1M	$24.0M	$30.5M	1.19	$6.6M	$10.9M	0.60	$19.7M	8.7%	$0.5M	$14.5M	0.03
UNDERGROUND CONST. COSTS												
LOW	$ 8.6M	$20.5M	$29.5M	1.00	$6.7M	$11.5M	0.58	$24.8M	13.9%	$0.5M	$15.0M	0.03
HIGH	$11.5M	$26.0M	$34.6M	1.08	$6.8M	$11.5M	0.59	$19.2M	7.2%	$0.5M	$15.0M	0.03
STUDIO COSTS												
$400K/$100K	$10.2M	$23.4M	$32.8M	1.05	$6.7M	$11.5M	0.58	$22.1M	11.0%	$0.5M	$15.0M	0.03
$1M/$500K	$11.1M	$27.3M	$35.9M	1.10	$6.8M	$11.5M	0.59	$18.3M	5.4%	$0.5M	$15.0M	0.03
OTHER PROGRAM COSTS												
$0/Yr./Sub.	$ 8.7M	$18.1M	$31.2M	0.88	$4.6M	$11.5M	0.42	$43.6M	26.0%	$1.8M	$ 3.8M	0.43
$3.50/Yr./Sub.	$ 8.9M	$19.6M	$31.2M	0.91	$5.5M	$11.5M	0.48	$35.5M	20.5%	$0.9M	$ 8.0M	0.11
$15.50/Yr./Sub.	$10.9M	$26.5M	$31.2M	1.20	$7.9M	$11.5M	0.69	$ 9.3M	0.0%	$0.5M	$22.2M	0.02
INSTALLATION FEE												
$0/Sub.	$10.7M	$24.0M	$31.2M	1.11	$6.7M	$11.5M	0.58	$22.1M	10.3%	$0.5M	$15.0M	[illegible]
$5/Sub.	$10.1M	$23.7M	$31.2M	1.07	$6.7M	$11.5M	0.58	$22.3M	11.4%	$0.5M	$15.0M	0.03
PENETRATION AT SUB. FEE												
75% at $5/Mo.	$8.8M	$16.0M	$31.0M	0.74	$6.6M	$14.3M	0.46	$58.2M	29.4%	[illegible]	$14.9M	0.29
50% at $4/Mo.	$8.6M	$25.6M	$26.5M	1.10	$5.6M	$9.9M	0.56	$21.3M	12.4%	$0.6M	$11.2M	0.05
LEASED CHANNEL RATES TELECASTING												
$0/Hr./Chan	$10.8M	$24.1M	$31.2M	1.10	$6.7M	$11.1M	0.61	$17.6M	7.5%	$0.5M	$15.0M	0.03
$50/Hr./Chan	$ 9.6M	$20.4M	$31.2M	0.95	$6.8M	$12.3M	0.55	$30.5M	17.1%	$0.6M	$15.0M	0.04
$100/Hr./Chan	$ 8.9M	$18.1M	$31.2M	0.87	$6.8M	$13.5M	0.50	$43.6M	23.9%	$1.8M	$15.0M	0.12
POINT-TO-POINT												
$0/Hr./Chan	$10.6M	$24.3M	$31.2M	1.11	$6.7M	$11.0M	0.61	$16.6M	6.1%	$0.5M	$15.0M	0.03
$2/Hr./Chan	$10.3M	$23.3M	$31.2M	1.08	$6.7M	$11.2M	0.60	$19.8M	9.2%	$0.5M	$15.0M	0.03
$6/Hr./Chan	$ 9.6M	$21.9M	$31.2M	1.00	$6.7M	$11.8M	0.57	$26.0M	14.3%	$0.5M	$15.0M	0.03
ADVERTISING RATES												
$0/Min	$10.6M	$24.2M	$31.2M	1.11	$6.7M	$10.9M	0.61	$16.6M	6.1%	$0.5M	$15.0M	0.03
$400/Min	$ 9.6M	$20.8M	$31.2M	0.97	$6.7M	$12.2M	0.55	$29.3M	16.5%	$0.5M	$15.0M	0.03

TABLE VII-2 (Concluded)

	EQUITY REQUIRED	LOANS REQUIRED	CAPITAL EXPENDITURES	EQUITY + LOANS / CAPITAL EXPEND	OPERATING EXPENSES, YR. 10	GROSS REVENUE YR. 10	OPERATING EXP. / GROSS REV.	EQUITY VALUE, YR 10	RATE-OF-RETURN ON EQUITY, YR 10	CASH BALANCE, YR 10	10 YR. PROGRAMMING COSTS	CASH BALANCE / PROG. COST
MARKET VALUE												
5 X Oper. Income	$9.9M	$22.8M	$31.2M	1.05	$6.7M	$11.5M	0.58	$13.0M	3.8%	$0.5M	$15.0M	0.03
10 X Oper. Income	$9.9M	$22.8M	$31.2M	1.05	$6.7M	$11.5M	0.58	$37.1M	19.4%	$0.5M	$15.0M	0.03
ORGANIZATIONAL VARIATIONS												
MULTIPLE FRANCHISES, 5 (76% Pen.at $3.50/Mo./Sub.)												
SECTOR 1	$2.3M	$4.4M	$7.1M	0.94	$1.6M	$2.6M	0.61	$6.3M	12.6%	$0.1M	$4.9M	0.02
SECTOR 2	$2.5M	$6.2M	$6.8M	1.28	$1.5M	$2.2M	0.70	$0.7M	0.0%	$0.1M	$4.3M	0.02
SECTOR 3	$2.2M	$4.4M	$7.6M	0.87	$1.5M	$2.8M	0.54	$9.1M	17.3%	$0.1M	$5.1M	0.02
SECTOR 4	$2.7M	$5.5M	$9.0M	0.91	$1.7M	$3.0M	0.57	$8.2M	13.3%	$0.1M	$5.4M	0.02
SECTOR 5	$2.7M	$8.0M	$4.1M	2.60	$1.0M	$1.0M	1.07	-$5.9M	<-80%	$0.1M	$2.4M	0.04
MULTIPLE FRANCHISES, 5 (75% Pen. at $5.00/Mo./Sub.)												
SECTOR 1	$2.0M	$3.6M	$7.0M	0.80	$1.6M	$3.4M	0.48	$14.8M	25.2%	$2.5M	$4.8M	0.52
SECTOR 2	$2.0M	$4.1M	$6.8M	0.90	$1.6M	$2.8M	0.55	$9.3M	18.8%	$0.4M	$4.3M	0.09
SECTOR 3	$1.9M	$3.9M	$7.6M	0.76	$1.6M	$3.7M	0.43	$18.1M	28.9%	$3.5M	$5.1M	0.69
SECTOR 4	$2.3M	$4.8M	$8.9M	0.80	$1.7M	$3.6M	0.45	$17.8M	25.7%	$2.8M	$5.3M	0.53
SECTOR 5	$1.9M	$6.0M	$4.1M	1.93	$1.0M	$1.3M	0.83	-$2.6M	<-80%	$0.1M	$2.3M	0.04
MULTIPLE FRANCHISES, 5 (50% Pen. At $5.00/Mo./Sub.)												
SECTOR 1	$1.8M	$4.0M	$6.0M	0.97	$1.3M	$2.2M	0.59	$5.7M	13.2%	$0.1M	$3.7M	0.03
SECTOR 2	$2.2M	$4.7M	$5.9M	1.34	$1.3M	$1.9M	0.70	$0.2M	-0.1%	$0.1M	$3.4M	0.03
SECTOR 3	$2.0M	$3.8M	$6.5M	0.89	$1.3M	$2.4M	0.52	$8.8M	17.6%	$0.6M	$3.9M	0.15
SECTOR 4	$2.5M	$4.8M	$7.8M	0.94	$1.4M	$2.6M	0.55	$7.9M	13.5%	$0.1M	$4.1M	0.02
SECTOR 5	$2.6M	$7.5M	$3.7M	2.83	$1.0M	$0.8M	1.13	-$6.0M	<-80%	$0.1M	$1.9M	0.05
MULTIPLE FRANSHISES, 5 (76% Pen. and Sub. Fees Prop. To Capital Costs)												
SECTOR 1	$2.3M	$4.6M	$7.1M	0.97	$1.6M	$2.5M	0.62	$5.4M	10.2%	$0.1M	$4.9M	0.02
SECTOR 2	$2.5M	$6.2M	$6.8M	1.28	[illegible]	$2.2M	0.70	$0.8M	[illegible]	$0.1M	$4.3M	0.02
SECTOR 3	$2.2M	$4.6M	$7.6M	0.90	$1.5M	$2.7M	0.57	$7.4M	14.6%	$0.1M	$5.1M	0.02
SECTOR 4	$2.7M	$5.6M	$9.0M	1.03	$1.7M	$3.0M	0.57	$7.7M	12.5%	$0.1M	$5.4M	0.02
SECTOR 5	$2.1M	$6.2M	$4.1M	1.97	$1.1M	$1.2M	0.87	-$3.0M	<-80%	$0.1M	$2.4M	0.04

TABLE VII-3
BASIC VALUES FOR PARAMETERS USED IN BASE CASE FOR TWO-WAY SUBSCRIBER RESPONSE SYSTEMS

FINANCIAL PARAMETER	BASIC VALUES
Debt: Equity	2:1
Interest Rate	8%
SYSTEM PARAMETERS	
Growth Curve	Medium
Underground Construction Costs	Medium
Studio Costs	$100K/$50K
Other Programming Costs	$25.25/Yr./Sub.
Subscriber Response Terminal Capital Costs	$127/$177 Per Sub.
Installation Fee, 65% of Subscribers	$10/Sub.
Penetration at Subscriber Fee	78% at $6.50/Mo./Sub.
Leased Channel Rates, 10th Year	
Telecasting, 32 Channels	$20/Hr./Channel
Point-to-Point, 100 Channels	$4/Hr./Channel
Advertising Rates, Incl. All Cablecasting Channels, 10th Year	$200/Min.
Utility, Maintenance, Alarms, Etc. Rates	$2/Mo./Hhld
Market Value	7 X Oper. Income
ORGANIZATIONAL STRUCTURE	
Number of Franchises	1

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[7] Includes cost of set-top converter

TABLE VII-4
SENSITIVITY ANALYSES
TWO-WAY SUBSCRIBER RESPONSE SYSTEMS

	EQUITY REQUIRED	LOANS REQUIRED	CAPITAL EXPENDITURES	EQUITY + LOANS / CAPITAL EXPEND.	OPERATING EXPENSES, YR. 10	GROSS REVENUES, YR. 10	OPERATING EXP. / GROSS REV.	EQUITY VALUE, YR. 10	RATE-OF-RETURN ON EQUITY, YR. 10	CASH BALANCE, YR. 10	10 YR. PROGRAMMING COSTS	CASH BALANCE / PROG. COST
BASE CASE												
2-WAY SR SYSTEM (CITY-WIDE)	$18.7M	$35.6M	$61.2M	0.89	$11.1M	$26.3M	0.42	$115.8M	30.2%	$20.3M	$34.3M	0.59
FINANCIAL VARIATIONS												
DEBT:EQUITY												
1:1	$26.8M	$27.0M	$61.2M	0.88	$11.1M	$26.3M	0.42	$126.1M	25.3%	$24.1M	$34.3M	0.70
5:1	$10.4M	$44.7M	$61.2M	0.90	$11.1M	$26.3M	0.42	$104.9M	40.0%	$16.1M	$34.3M	0.47
INTEREST RATE												
6%	$18.7M	$35.1M	$61.2M	0.88	$11.1M	$26.3M	0.42	$117.9M	30.5%	$20.9M	$34.3M	0.61
10%	$18.7M	$36.2M	$61.2M	0.90	$11.1M	$26.3M	0.52	$113.6M	29.8%	$[illegible].7M	$34.3M	0.57
SYSTEM VARIATIONS												
GROWTH CURVE												
FAST	$19.1M	$36.7M	$61.3M	0.91	$11.1M	$26.4M	0.42	$126.5M	31.7%	$25.7M	$41.6M	0.62
SLOW	$18.6M	$35.7M	$60.5M	0.90	$10.7M	$25.3M	0.42	$109.6M	29.4%	$19.1M	$32.9M	0.58
UNDERGRND COSTS												
LOW	$17.9M	$34.0M	$59.0M	0.71	$11.1M	$26.3M	0.42	$117.4M	31.5%	$20.9M	$34.3M	0.61
HIGH	$20.5M	$38.7M	$65.6M	0.90	$11.1M	$26.3M	0.42	$112.5M	27.8%	$19.2M	$34.3M	0.56
STUDIO COSTS												
$300K/$100K	$19.0M	$36.0M	$61.9M	0.89	$11.1M	$26.3M	0.42	$115.4M	29.8%	$20.1M	$34.3M	0.59
$1M/$500K	$20.3M	$39.2M	$65.9M	0.90	$11.1M	$26.3M	0.42	$112.3M	28.0%	$18.3M	$34.3M	0.53
OTHER PROGRAM COSTS												
$0/Yr./Sub.	$17.9M	$33.9M	$61.2M	0.85	$5.6M	$26.3M	0.22	$169.3M	38.6%	$31.2M	$3.8M	8.23
$19.25/Yr./Sub.	$18.7M	$35.0M	$61.2M	0.88	$9.9M	$26.3M	0.37	$128.5M	32.2%	$23.2M	$27.0M	0.86
$31.25/YYr./Sub.	$18.8M	$36.2M	$61.2M	0.90	$12.3M	$26.3M	0.47	$103.0M	28.0%	$17.4M	$41.6M	0.42
SUBSCRIBER RESPONSE TERMINAL CAPITAL COSTS												
$127/Sub.	$17.3M	$34.1M	$56.9M	0.90	$11.0M	$26.3M	0.42	$116.7M	31.9%	$20.9M	$34.3M	0.61
$177/Sub.	$31.4M	$56.3M	$87.6M	1.00	$11.4M	$26.3M	0.43	$ 92.0M	18.9%	$19.8M	$34.3M	0.58
INSTALLATION FEE												
$0/Sub.	$18.9M	$36.0M	$61.2M	[illegible]	$11.1M	$26.3M	0.42	$115.0M	29.9%	$19.9M	$34.3M	0.58
$5/Sub.	$18.8M	$35.8M	$61.2M	0.89	$11.1M	$26.3M	0.42	$115.4M	30.0%	$20.1M	$34.3M	0.59
PENETRATION AT SUB FEE												
75% at $8/Mo.	$18.2M	$34.3M	$60.7M	0.87	$10.9M	$29.1M	0.38	$146.3M	35.4%	$27.1M	$33.1M	0.82
50% at $8/Mo.	$14.9M	$28.5M	$47.8M	0.91	$ 8.4M	$21.5M	0.39	$103.4M	31.8%	$17.5M	$23.4M	0.75
LEASED CHANNEL RATES TELECASTING												
$0/Hr./Chan.	$18.8M	$36.2M	$61.2M	0.89	$11.0M	$25.0M	0.44	$102.5M	27.9%	$17.3M	$34.3M	0.50
$50/Hr./Chan.	$18.3M	$35.0M	$61.2M	0.87	$11.2M	$28.3M	0.39	$135.2M	33.8%	$24.4M	$34.4M	0.71
$100/Hr./Chan.	$17.9M	$33.9M	$61.2M	0.85	$11.3M	$31.6M	0.36	$167.9M	38.5%	$31.6M	$34.3M	0.92

TABLE VII-4 (Concluded)

	EQUITY REQUIRED	LOANS REQUIRED	CAPITAL EXPENDITURES	EQUITY + LOANS / CAPITAL EXPEND.	OPERATING EXPENSES, YR. 10	GROSS REVENUES, YR. 10	OPERATING EXP. / GROSS REV.	EQUITY VALUE, YR. 10	RATE OF RETURN ON EQUITY, YR. 10	CASH BALANCE, YR. 10	10 YR. PROGRAMMING COSTS	CASH BALANCE / PROG. COSTS
LSD CHAN. RATES POINT-TO-POINT												
$0/Hr./Chan.	$18.8M	$35.9M	$61.2M	0.89	$11.1M	$25.7M	0.43	$109.4M	29.1%	$18.9M	$34.3M	0.55
$2/Hr./Chan.	$18.8M	$35.7M	$61.2M	0.89	$11.1M	$26.0M	0.43	$112.6M	29.7%	$19.6M	$34.3M	0.57
$6/Hr./Chan.	$18.7M	$35.6M	$61.2M	0.89	$11.1M	$26.6M	0.42	$119.0M	30.7%	$21.0M	$34.3M	0.61
ADVERTISING RATES												
$0/Min.	$18.8M	$35.9M	$61.2M	0.90	$11.1M	$25.7M	0.43	$109.8M	29.1%	$18.9M	$34.3M	0.55
$400/Min.	$18.7M	$35.8M	$61.2M	0.89	$11.1M	$27.0M	0.41	$122.2M	31.2%	$21.9M	$34.3M	0.63
UTILITIES, ETC. RATES												
$0/Mo./Hhld.	$20.0M	$42.2M	$61.2M	1.02	$10.8M	$20.3M	0.54	$41.1M	12.2%	$5.1M	$34.3M	0.15
$3/Mo./Hhld	$18.5M	$34.5M	$61.2M	0.87	$11.2M	$29.5M	0.38	$149.2M	35.1%	$27.7M	$34.3M	0.81
MARKET VALUE												
5 X Oper Income	$18.7M	$35.6M	$61.2M	0.89	$11.1M	$26.3M	0.42	$85.[illegible]	24.7%	$20.3M	$34.3M	0.59
10 X Oper Income	$18.7M	$35.6M	$61.2M	0.89	$11.1M	$26.3M	0.42	$161.[illegible]	36.4%	$20.3M	$34.3M	0.59
ORGANIZATIONAL VARIATIONS												
MULTIPLE FRANCHISES, 5 (78% PEN. At $6.50/Mo/SUB)												
SECTOR 1	$ 3.7M	$ 8.0M	$12.9M	0.91	$ 2.4M	$ 5.9M	0.41	$30.5M	26.3%	$ 6.0M	$ 9.5M	0.63
SECTOR 2	$ 3.3M	$ 7.1M	$11.4M	0.91	$ 2.3M	$ 5.0M	0.46	[illegible]	23.9%	$ 4.1M	$ 8.8M	0.47
SECTOR 3	$ 4.0M	$ 7.4M	$13.7M	0.82	$ 2.8M	$ 6.4M	0.40	$36.1M	27.7%	$ 7.1M	$11.[illegible]	0.81
SECTOR 4	$ 4.2M	$ 7.9M	$16.0M	0.76	$ 3.0M	$ 6.9M	0.43	$35.8M	26.7%	$ 8.5M	$11.0M	[illegible]
SECTOR 5	$ 1.8M	$ 3.8M	$ 6.[illegible]	0.89	$ 1.6M	$ 2.2M	0.66	$ 4.9M	11.7%	$ 0.1M	$ 4.6M	0.02
MULTIPLE FRANCHISES, 5 (75% PEN. AT $8.00/Mo/SUB)												
SECTOR 1	$ 3.7M	$ 7.3M	$12.8M	0.86	$ 2.4M	$ 6.5M	0.36	$38.0M	29.6%	$ 8.9M	$ 9.2M	0.97
SECTOR 2	$ 3.3M	$ 6.8M	$11.[illegible]	0.89	$ 2.3M	$ 5.5M	0.41	$29.2M	27.5%	$ 6.6M	$ 8.5M	0.78
SECTOR 3	$ 3.9M	$ 7.3M	$13.6M	0.83	$ 2.5M	$ 7.1M	0.36	$44.2M	30.8%	$12.2M	$10.9M	1.12
SECTOR 4	$ 4.2M	$ 7.8M	$15.8M	0.76	$ 2.9M	$ 7.6M	0.38	$44.3M	29.9%	$11.7M	$12.6M	0.93
SECTOR 5	$ 1.8M	$ 3.5M	$ 6.2M	0.86	$ 1.4M	$ 2.4M	0.58	$ 8.0M	18.1%	$ 0.8M	$ 4.5M	0.18
MULTIPLE FRANCHISES, 5 (50% PEN. AT $8.00/Mo/SUB)												
SECTOR 1	$ 3.1M	$ 6.6M	$10.2M	0.95	$ 1.9M	$ 4.9M	0.39	$26.2M	26.9%	$ 5.4M	$ 6.7M	0.81
SECTOR 2	$ 2.8M	$ 5.9M	$ 9.1M	0.96	$ 1.8M	$ 4.1M	0.45	$19.6M	24.3%	$ 3.8M	$ 6.2M	0.61
SECTOR 3	$ 3.3M	$ 6.1M	$10.8M	0.87	$ 1.9M	$ 5.3M	0.37	$32.0M	28.8%	$ 8.6M	$ 7.6M	1.13
SECTOR 4	$ 3.5M	$ 5.5M	$12.9M	0.78	$ 2.2M	$ 5.6M	0.40	$31.7M	27.7%	$ 8.2M	$ 8.9M	0.92
SECTOR 5	$ 1.6M	$ 3.7M	$ 5.2M	0.92	$ 1.7M	$ 1.8M	0.66	$ 3.4M	9.1%	$ 0.1M	$ 3.3M	0.03
MULTIPLE FRANCHISES, 5 (78% PENETRATION AND SUB. FEES PROP. TO CAPITAL COSTS)												
SECTOR 1	$ 3.7M	$ 8.2M	$12.9M	0.92	$ 2.4M	$ 5.6M	0.42	$29.0M	25.6%	$5.4M	$ 9.5M	0.57
SECTOR 2	$ 3.3M	$ 7.1M	$11.4M	0.91	$ 2.3M	$ 5.0M	0.46	[illegible]	23.8%	$4.0M	$ 8.8M	0.46
SECTOR 3	$ 4.0M	$ 7.5M	$13.7M	0.84	$ 2.6M	$ 6.3M	0.42	$36.0M	26.8%	$8.3M	$11.7M	0.78
SECTOR 4	$ 4.2M	$ 7.9M	$16.0M	0.75	$ 3.0M	$ 6.9M	0.41	[illegible]	26.9%	$8.6M	$13.0M	0.66
SECTOR 5	$ 1.8M	$ 3.5M	$ 6.3M	0.84	$ 1.4M	$ 2.5M	0.58	$ 6.2M	18.4%	$0.8M	$ 4.6M	0.17

TABLE VII-5
BASIC VALUES FOR PARAMETERS USED IN BASE CASE FOR ELECTRONIC INFORMATION HANDLING SYSTEMS[8]

SYSTEM PARAMETER	BASIC VALUES
Capital Cost of EIH Terminals	$427/Sub.
EIH System Penetration at Subscriber Fee	47% at $22 Mo/Sub.
Maintenance Factor	8% of capital costs
Other Programming Costs	$45.27/year/sub.
ORGANIZATIONAL STRUCTURE	
Number of Franchises	1

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[8] Other basic values same as for the base case for Subscriber Response System (see Table VII-3).

TABLE VII-6
SENSITIVITY ANALYSES
ELECTRONIC INFORMATION HANDLING SYSTEMS

	EQUITY REQUIRED	LOANS REQUIRED	CAPITAL EXPENDITURES	EQUITY + LOANS / CAPITAL EXPEND	OPERATING EXPENSES, YR. 10	GROSS REVENUE YR. 10	OPERATING EXP. / GROSS REVENUE	EQUITY VALUE, YR. 10	RATE-OF-RETURN ON EQUITY, YR. 10	CASH BALANCE YEAR 10	10 YR. PROGRAMMING COSTS	CASH BALANCE / PROG. COST
BASE CASE												
2-WAY EIH SYSTEM (CITY-WIDE)	$39.2M	$ 77.9M	$114.0M	1.02	$20.1M	$49.2M	0.41	$209.4M	28.4%	$46.8M	$58.5M	0.80
SYSTEM VARIATIONS												
EIH SYSTEM TERMINAL COSTS												
$327/Sub.	$34.7M	$ 67.3M	$101.7M	1.01	$19.6M	$49.2M	0.40	$229.1M	31.9%	$47.2M	$58.5M	0.82
$627/Sub.	$49.8M	$101.2M	$138.7M	1.08	$21.1M	$49.2M	0.43	$171.9M	21.2%	$46.0M	$58.5M	0.79
EIH SYSTEM PENETRATION AT SUBSCRIBER FEE												
20% at $22/Mo.	$36.3M	$ 70.4M	$ 99.2M	1.08	$18.9M	$35.0M	0.54	$ 87.9M	14.4%	$18.5M	$58.5M	0.32
37% at $26/Mo.	$36.3M	$ 70.9M	$106.1M	1.01	$19.8M	$49.1M	0.40	$221.1M	30.5%	$46.5M	$58.5M	0.79
53% at $18/Mo.	$42.3M	$ 83.2M	$118.9M	1.05	$20.2M	$45.4M	0.44	$216.0M	22.8%	$39.1M	$58.5M	0.67
60% at $15/Mo.	$48.1M	$ 97.0M	$125.4M	1.12	$20.5M	$42.2M	0.48	$115.8M	14.8%	$32.3M	$58.5M	0.55
O&M FACTOR												
5%	$38.1M	$ 71.4M	$114.0M	0.96	$16.7M	$49.2M	0.34	$255.3M	32.7%	$51.4M	$58.5M	0.88
11%	$42.7M	$ 86.8M	$114.0M	1.14	$23.5M	$49.2M	0.48	$166.0M	23.0%	$42.1M	$58.5M	0.72
14%	$49.1M	$ 98.5M	$114.0M	1.29	$26.9M	$49.2M	0.55	$137.2M	16.0%	$37.5M	$58.5M	0.64
OTHER PROGRAM COSTS												
$35.25/Yr/Sub.	$39.1M	$ 76.3M	$114.0M	1.01	$18.1M	$49.2M	0.37	$232.1M	30.4%	$51.6M	$46.4M	1.12
ORGANIZATIONAL VARIATIONS												
MULTIPLE FRANCHISES, 5 (78%/47% PEN at $6.50/$22 Per Mo. Per Sub.)												
SECTOR 1	$ 8.0M	$ 15.5M	$ 24.8M	0.99	$ 4.4M	$11.1M	0.40	$ 58.0M	24.9%	$12.4M	$16.6M	0.75
SECTOR 2	$ 6.9M	$ 13.6M	$ 21.3M	0.96	$ 4.0M	$ 9.3M	0.43	$ 46.7M	23.7%	$ 9.5M	$14.8M	0.64
SECTOR 3	$ 8.6M	$ 16.0M	$ 26.7M	0.92	$ 4.8M	$12.1M	0.40	$ 66.8M	25.6%	$15.9M	$19.4M	0.82
SECTOR 4	$ 9.0M	$ 16.8M	$ 29.5M	0.88	$ 5.3M	$12.8M	0.41	$ 68.6M	25.3%	$15.9M	$21.2M	0.75
SECTOR 5	$ 3.4M	$ 6.5M	$ 10.6M	0.93	$ 2.2M	$ 4.1M	0.53	$ 15.3M	18.4%	$ 1.8M	$ 7.3M	0.25
MULTIPLE FRANCHISES, 5 (75%/47% Pen. at $8/22 Per Mo. Sub)												
SECTOR 1	$ 7.9M	$ 15.1M	$ 24.7M	0.93	$ 4.4M	$11.7M	0.37	$ 67.1M	26.8%	$15.5M	$16.1M	0.96
SECTOR 2	$ 6.8M	$ 13.2M	$ 21.2M	0.96	$ 3.9M	$ 9.8M	0.40	$ 53.6M	25.7%	$12.1M	$14.2M	0.96
SECTOR 3	$ 8.6M	$ 15.9M	$ 26.6M	0.92	$ 4.7M	$12.8M	0.37	$ 75.6M	27.4%	$19.3M	$18.7M	1.03
SECTOR 4	$ 9.0M	$ 16.7M	$ 29.4M	0.88	$ 5.2M	$13.6M	0.38	$ 77.8M	27.2%	$19.4M	$20.5M	0.95
SECTOR 5	$ 3.3M	$ 6.3M	$ 10.5M	0.91	$ 2.2M	$ 4.4M	0.50	$ 18.4M	20.9%	$ 3.1M	$ 7.0M	0.44
MULTIPLE FRANCHISES, 5 (50%/31% Pen. at $8/$22 Per Mo. Sub)												
SECTOR 1	$ 6.3M	$ 12.4M	$ 19.1M	0.99	$ 3.3M	$ 8.2M	0.40	$ 43.0M	23.8%	$ 8.5M	$11.2M	0.87
SECTOR 2	$ 5.4M	$ 11.0M	$ 16.5M	1.00	$ 3.0M	$ 6.9M	0.43	$ 33.5M	22.4%	$ 6.3M	$10.0M	0.63
SECTOR 3	$ 6.8M	$ 12.6M	$ 20.6M	0.94	$ 3.4M	$ 8.9M	0.38	$ 50.5M	25.0%	$12.1M	$13.0M	0.93
SECTOR 4	$ 7.1M	$ 13.1M	$ 23.0M	0.87	$ 3.9M	$ 9.5M	0.41	$ 51.0M	24.5%	$11.7M	$14.2M	0.83
SECTOR 5	$ 2.7M	$ 5.3M	$ 8.4M	0.95	$ 1.8M	$ 3.1M	0.57	$ 9.5M	15.0%	$ 0.4M	$ 5.0M	0.08

exceeded revenues for the first ten years. If this is the case, the system would not be very viable and would probably have difficulty in attracting equity capital or loans.

Operating Expenses, Year Ten - This represents the operating expenses of the system in the tenth year of system operations.

Gross Revenues, Year Ten - This represents the gross revenues collected in the tenth year of system operations.

Operating Expenses/Gross Revenues, Year Ten - This ratio should, normally, be less than about 0.50 for the system to be economically viable, based on the experience of cable operators.

Equity Value of System, Year Ten - This has been calculated on the basis of the formula of seven times operating income, plus cash surplus, minus outstanding debts of the system, in the tenth year. Comparison of this value with the equity required (i.e., the first column) provides an estimate of the change in equity value over the ten year period of system operation that has been considered.

Internal Rate-of-Return on Equity, Year Ten - This is equivalent to the compound interest rate on the equity required (i.e., the first column) that must be realized to reach the estimated equity value of the system in the tenth year (i.e., column 8).

Cash Balance, Year Ten - This is the estimated cash balance for each system variation, in the tenth year of system operation. This could be either distributed as dividends to the stockholders or turned back into improved programming including the basic programming cost of

$3.8 M for the ten years, plus the number of dollars per subscriber allowed for other programming. This does not include costs for computer programming in the EIH base cases and variations. In those cases, these additional programming costs are included in the pro rata cost of the EIH terminal. The cash balance could also be used for extra EIH computer programming.

Cash Balance/Ten-Year Programming Costs - This ratio has been included in the tables to estimate the percentage increase in programming budgets that could be achieved if system profits were turned back into the system for this purpose.

DISCUSSION OF RESULTS

In comparing the results of these sensitivity analyses, as summarized in Tables VII-2, VII-4, and VII-6 it is interesting to note the following points:

- The interest rate on loans, the debt-to-equity ratio used and the method of estimating the market value of the system, all have a significant impact on the estimated rate-of-return on equity.
- Uncertainties in the system penetration, as a function of subscriber fee, for different levels of service, are probably the most significant system uncertainties in the analyses of the base cases.
- The most important uncertainty in determining the capital cost of two-way systems is the cost of the home terminals, and, for

the EIH Systems, the headend computers required for two-way services.

. Some of the variations shown in Tables VII-2, VII-4 and VII-6, would indicate that high rates of return on equity could be produced by lowering the studio costs or the programming costs. However, these cases were included for sensitivity analysis purposes only. It is doubtful that the penetrations assumed in the base cases, at the subscriber fees indicated could be achieved for urban systems without relatively sophisticated programming. This, in turn, will probably require relatively expensive studio equipment, including color cameras and mobile studios as well as budgets for first run movies, sporting events coverage, etc.

. The cost of system maintenance, and in particular, home terminal maintenance can be an important factor in determining the economic viability of a sophisticated two-way urban cable system since such a large fraction of the total capital expenditures is for the home terminals. This emphasizes the need for both reliable equipment and possibly the remote maintenance checking of this equipment through the use of the cable system.

. A fast growth curve can increase the rate-of-return on equity by significant amounts over cases using medium or slow growth curves. This emphasizes the importance of providing demonstration need for both reliable equipment and remote maintenance checking of this equipment through the use of the cable system.

- A fast growth curve can increase the rate-of-return on equity by significant amounts over cases using medium or slow growth curves. This emphasizes the importance of providing demonstration projects and market surveys, prior to system implementation, that will determine the most acceptable mixtures of services, before investing large amounts in the construction of sophisticated, large-scale cable communication systems in urban areas.
- The reduced rates for leased channels that have been assumed in the base cases to promote the use of these types of channels by the public, and others, do not appear to affect the economic viability of the system to any appreciable extent.
- The maximum benefits from economies-of-scale in the purchase of cable amplifiers and terminals can probably be attained within the individual franchise sectors that have been selected for this study. However, significant economies in studio costs, management costs, programming costs, and other operating costs could probably be attained with a single large system operating under a citywide franchise, rather than with small systems operating under separate franchises.
- The granting of multiple franchises for one-way systems in Washington, D. C. would probably result in marginal economic

viability in at least two of the five Sectors into which the city was divided if the Service Area combinations, selected here, are used to partition off the city into franchise areas. This is due to such factors as low subscriber density in some parts of the city and the high cost of duct-work required for underground cable installation in the central city.

- The lack of economic viability in two sectors could probably be overcome if the franchises required that two-way services be provided that could achieve high public acceptance at the subscriber fee stipulated for the basic two-way services. However, such systems would require considerably higher capital costs and programming budgets than has been indicated here for the basic One-Way System.

These results point to the requirement for improved service demonstrations and market surveys of the types outlined in the next Section.

SECTION VIII

DEMONSTRATIONS

INTRODUCTION

Initiation of services through the use of a new communications medium presents a dilemma. Delivery, via cable, of many of the types of public services discussed in Section III has never been tried before. Furthermore, the economic viability of many possible entertainment and commercial cable services has not been adequately tested in many of the top markets. System operators and financial establishments must be convinced that there is a firm demand for these cable services, at subscriber fees that will make them economically feasible, before they will be willing to invest in urban cable systems. Subscribers, on the other hand, want to view new types of programming as well as use and test new types of services before they agree to pay for them. Beyond the question of economic viability, there are uncertainties as to how cable is going to provide many of these new services, particularly those of a public-interest nature. Many new organizational entities will be required, both governmental and private, to develop and sponsor various applications. Sources of programming and funding will have to be developed. Demonstrations with associated market surveys can provide a useful experimental vehicle through which the many facets of these problems can be formulated and explored.

This section suggests typical demonstrations and surveys that might be implemented in an urban area to quantitatively test, over a period of time, the capabilities and public acceptability of new telecommunications services that might be used to address urban needs and opportunities in an effective fashion. These demonstrations would offer services typical of those discussed under Programming and Services (Section III) and would employ the types of telecasting and point-to-point nets described in Section IV.

The wide diversity of backgrounds, experiences, desires and needs of the citizens of large urban areas means that a wide variety of services will have to be provided. It is MITRE's belief that no one service in the one-way, subscriber response or electronic information-handling categories will make that types of system economically viable. Therefore, the identification of an aggregated market becomes mandatory.

In addition, the desired grouping of service options will probably also vary as a function of time, geographic location, and shifting population groupings. It becomes obvious that the system configuration selected by urban cable planners must have long-term flexibility to respond to these varying demands.

Prior to full-scale implementation of a specific urban cable system, many of these demonstrations and evaluations could be accomplished through the use of existing urban cable systems or some portion of a new urban cable system as it is being implemented. As an alternative, existing educational television or public broadcasting facilities could be used to demonstrate some of these services in a community before a substantial capital investment is made in the installation of an advanced cable system capable of supplying a wide variety of advanced types of programming and services. Many of these types of demonstrations could also be provided via long-line video circuits or satellite communications links between remote communities. Results of demonstrations conducted in one community could be used to estimate the acceptability of these services in similar communities in other parts of the nation.

The following demonstration projects are suggested as illustrative of what could be done within the various services categories:

One-Way Services
Local Community Programming

Subscriber Response Services
Subscriber Polling and Automatic Sensor Interrogation

Electronic Information-Handling Services
Interactive Educational Television

Special Services
Automatic Vehicle Monitoring

Point-to-Point Services
Health Care Delivery

It should also be pointed out that although the District of Columbia is used as a model, these demonstration projects are equally applicable to many other urban areas across the country. The costs of these demonstration projects include hardware and software that make these projects applicable to any urban cable system. For example, the costs for demonstration terminals are for small quantities of terminals and are not costs that would be available to a large quantity purchaser like the WCS. Courseware and programming costs for the projects are included in each of the demonstrations although a demonstration on the WCS would have available a portion of the programming funds discussed in Section VI, Financial Analysis, which amounted to $3.50/subscriber/year (one-way), $19.25/subscriber/year (subscriber response), $39.25/subscriber/year (electronic information handling).

The objectives of these demonstrations are multiple: to estimate market demand, to determine technical feasibility, to develop the potential of the medium for a variety of uses, to explore new institutional arrangements and to establish cost-effectiveness. These demonstrations could be implemented separately or collectively. The total cost would probably be reduced by integrating the separate projects into a small number of comprehensive demonstrations. The demonstrations suggested here are not only to test out the concepts but also to verify and test the functional and technical performance of the supportive hardware.

TECHNICAL IMPLEMENTATION

In terms of technical capability, demonstrations and associated market surveys of one-way services could be initiated as soon as a cable system is implemented. The One-way Systems are fundamentally the same as present cable systems, except that they offer more channels and more services on these channels. Implementation of subscriber response services could be considered in the second year of WCS operation after activation of a two-way distribution capability, the development of the necessary computer software and the refinement of the required home terminals and sensor technology. In the Subscriber Response System the subscriber would use push buttons to respond to questions presented on his TV set and automatic sensors would respond to interrogations initiated periodically by a central computer. Electronic Information-Handling services might not begin until about the third year, reflecting the complexity and amount of EIH programming required. EIH systems would allow home viewers to use typewriter-like keyboards to communicate with the system's computer center and possibly directly with computers of government and commercial institutions.

The use of frame-stopping services in Electronic Information Handling by thousands of simultaneous users requires not only the availability of tremendous amounts of program content and courseware materials, but also the development of sophisticated computer software. MITRE, under a National Science Foundation grant, is currently engaged in such software and courseware development on a prototype basis. As a result of increasing interest in EIH, more developmental work is expected in EIH courseware and software. The WCS should be able to draw upon the experience of others in this area, as a supplement to its own program of cable service demonstrations and market surveys.

INSTITUTIONAL IMPLEMENTATION

In actuality, the planning and organizational aspects for all the demonstrations and market surveys could be started before an urban cable system such as the WCS is in place. As indicated in Section III, municipal agencies need to estimate their channel requirements for a cable system even before the franchising ordinance is written, so that adequate channel space can be made available and allocated in the system that is franchised. In order to develop even a rough estimate of channel requirments some planning will have to be accomplished to outline the intended programming and services that would be provided by the cable. On a departmental basis, this process would probably be coordinated by a planning officer working with program staff members in developing a desirable set of cable applications, in terms of program definition, programming software or courseware needed, evaluation techniques required, cost-effectiveness measures that should be used in system evaluation (including those measures applying to organizational structure and operating procedures), personnel allocations and budget estimates. This process might also include the specification of the demonstration projects required as a means of further refinement and formulation of an operational program.

In addition to the work within a municipal department, some overall interagency executive coordination would be required to prevent duplication of efforts and, generally, to draw together requirements on a government-wide basis in order to provide a working interface with the cable operator. In the case of Washington, D.C., the Community Service Division of the Office of Planning and Management has been suggested as a logical organization to provide this function. For other urban areas, the particular group charged with coordination responsibilities could be worked out after consideration of the municipal organizational structure and consultation with municipal officials.

ONE-WAY SERVICES DEMONSTRATION

Local Community Programming

Purpose

One of cable television's many promises is that of becoming the "neighborhood TV network." The increased number of channels that can be provided by a cable distribution system could provide a means of access to the television medium by many individuals and community groups who have up to now been excluded from use of the medium by prohibitive production costs and the necessity for programming with mass appeal. On the other hand, cable has been called the "medium of the people" in that it can be programming by and for small community groups and individuals with localized interests. These local programs can be viewed during prime time or any other time that is convenient to the viewers. Cable is potentially a vehicle for improved personal and community expression and development. The Washington Cable System as well as other urban cable systems will be specifically designed so that they can provide a neighborhood TV network. It is the purpose of this demonstration project to provide training and local program production experience for those who want to use the cable system.

Currently a number of organizations are already trying to make the promise of public access become a reality. The Alternate Media Center at NYU and Open Channel, a New York-based non-profit organization are both working with community groups in that city in the development of local productions.[1] They are meeting with moderate success in spite of union problems, high production costs, few origination points, technical problems and lack of public awareness. A thorough study of the New York problems with public access to cable should be made in an attempt to avoid these problems in Washington and other urban areas. Every attempt should be made to develop attractive programming of community expression and local events.

Description

This demonstration project would establish a number of Production Assistance Teams to provide training, as well as technical assistance, to groups and individuals within the city who wished to develop community programming. This should be done on a first-come, first-served basis. Another function would be to inform the community of the public access capabilities of the cable system and how they could be utilized effectively to disseminate community information.

Production assistance for any of the types of groups listed above would range from providing a straightforward service such as facilities for planning, taping and editing of programs, and advice on set design and studio lighting, to more extensive assistance such as program formatting or the use of novel video techniques for presentation of programming ideas. It would not be necessary for a group to use the full assistance team or to use the team at all, if they did not want to do so. However, these capabilities would be available to those who wanted to use the medium effectively but who otherwise would not have the necessary technical skills or familiarity with the range of possibilities for program structure and content. The cost to individuals and groups using Production Assistance Teams might range from no charge, to materials cost only, to costs that would permit the system operator to make a reasonable profit on the services provided.

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[1] __________, "No rush to get on cables in New York," Broadcasting, September 27, 1971, pp. 29, 30.
Gent, G., "Public Access TV Here is Undergoing Growing Pains," New York Times, October 26, 1971.

Funding possibilities for such programming would include cable system sponsorship, as well as grants provided by the Federal or Municipal governments or various foundations that are interested in promoting increased community-oriented programming on cable systems. For the first six months, concentrated effort would be placed on promotional aspects and community education in the use of the medium. In addition to program publicity that could be provided on the cable, in neighborhood newspapers, community center bulletin boards and the like, these teams should actively seek out community groups to participate in such local programming demonstrations.

Cost of Demonstration

The following is a summary of the cost of a demonstration and market survey for local programming. This demonstration will provide local programming training, production experience and training. The program will run 15 months at a cost of $315,000. This will ultimately produce 20 hours per week of air-time programming for both studios used in this demonstration as a secondary benefit of the training.

Schedule:		
	3 months study and planning (6 man-months)	$ 20K
	12 months demonstration 4 teams @ 40K/year	160K
	Capital cost of two studios	100K*
	Maintenance for two studios	10K*
	Market Survey	25K
	TOTAL COST	$315K

This demonstration should be initiated early in the 5 year implementation plan for D.C. It would be carried out in Service Areas 2 and 7 (Phase 1) in order to provide development, demonstrations and market survey of local programming for use in later phases.

SUBSCRIBER-RESPONSE SERVICES DEMONSTRATION

Subscriber Polling and Automatic Sensor Interrogation

Purpose

In Section III, a number of potential two-way cable services employing interrogation from central computers and digital response from various types of manual and automatic sensors in the home have been suggested for use with wideband two-way cable systems. These include:

- Preference polling
- Shopping-at-home service

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*In demonstrating on the WCS, these costs would not be incurred, since the system design and financial analyses have already included studios.

- Meter reading systems for utility services (e.g., electricity, gas, water)
- Alarm sensor systems (e.g., intrusion, burglar, fire)
- Various electrical and mechanical output sensor systems for status monitoring operations and maintenance tests and checks (e.g., electronic system components, storage tank level indicators, selective control switches, pollution sensors)

The purpose of this demonstration would be to develop and demonstrate a subscriber polling and automatic sensor interrogation system capability. This capability would be able to provide any or all of the above types of services taking advantage of the rapid sampling rates made possible by computer polling via the cable. Such a system could minimize the cost of transmitting and interpreting the response signals and provide rapid reaction, if required.[2] The cost of the sensor terminals could be reduced to a minimum by performing all counting and other sensor data processing functions at central processing units rather than at each sensor.

It is estimated that the total incremental capital costs of equipping 300,000 utility meters for automatic remote reading in an urban area might be reduced to about $450,000 - $600,000 for systems utilizing two-way cable networks, as compared to an estimated cost of $3.3 to $6.3 million using present designs under development for use with telephone switched-networks.

While the provision of these services is a relatively simple technical concept, the ultimate implementation will have significant institutional effects. For example, automatic alarm systems presently result in very high false alarm rates. Because of this factor, many police departments will not permit direct response by their department. This may result in the need for private security forces. When the false alarm problem is corrected or reduced to a manageable level, the police departments may be willing to set up their own special squad to respond to automatic alarms. To take the example of automatic meter reading, the replacement of meter readers by an electronic device will not only affect a significant number of people, but it will also eliminate another category of available low skill entry jobs. Such secondary and non-technological effects of these advanced applications will need to be adequately provided for.

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[2] See Eldridge, F. R., "System for Automatic Reading of Utility Meters," The MITRE Corporation, M72-7, September 1971.

Description

The proposed demonstration would be performed in an area of the WCS such as S/A's 2 and 7 where two-way cable channels would be implemented early or in any other urban cable system with two-way capability. The experiment would require a single dedicated downstream channel and a single dedicated upstream channel in the telecasting network.

A wideband cable system could be expected to provide a sampling rate of up to 5000 terminal sites per second per channel, using a 200 microsecond query time per terminal site. For 300,000 terminal sites, therefore, a single central processing unit (CPU) could sequentially query and receive responses from up to 24 different sensor units and the subscriber response terminal in every household, office, business establishment, industrial site, in the city at a maximum rate of about once every 60 seconds. In comparison, a CPU utilizing the switched telephone network would require approximately 60 days to sequentially connect to and read the outputs of the terminals at each of these sites.

As shown in Figure VIII-1, each combined subscriber response and automatic sensor interrogation terminal would receive, demodulate, and monitor all interrogation messages sent from the CPU. As noted above, this same terminal would be useful in a number of other types of cable service applications.

The following Three-Phase Work Program would result in a demonstration of a prototype system for Automatic Sensor Interrogation (ASI):

PHASE I - PROTOTYPE SUBSCRIBER RESPONSE & SENSOR INTERROGATION SYSTEM DESIGN (3 Months)

- Review current classes of sensor interrogation systems, current costs and rate structures for such services, and estimated demand for such services
- Select and define classes of sensor interrogation services to be provided
- Develop evaluation criteria
- Analyze benefits and costs of alternative designs
- Prepare a preliminary design for selected prototype ASI System
- Prepare detailed cost estimates and analyze expected economic viability

PHASE II - SYSTEM IMPLEMENTATION (6 Months)

- Select site for prototype demonstration
- Assemble hardware and develop installation plans
- Prepare software
- Install and debug system

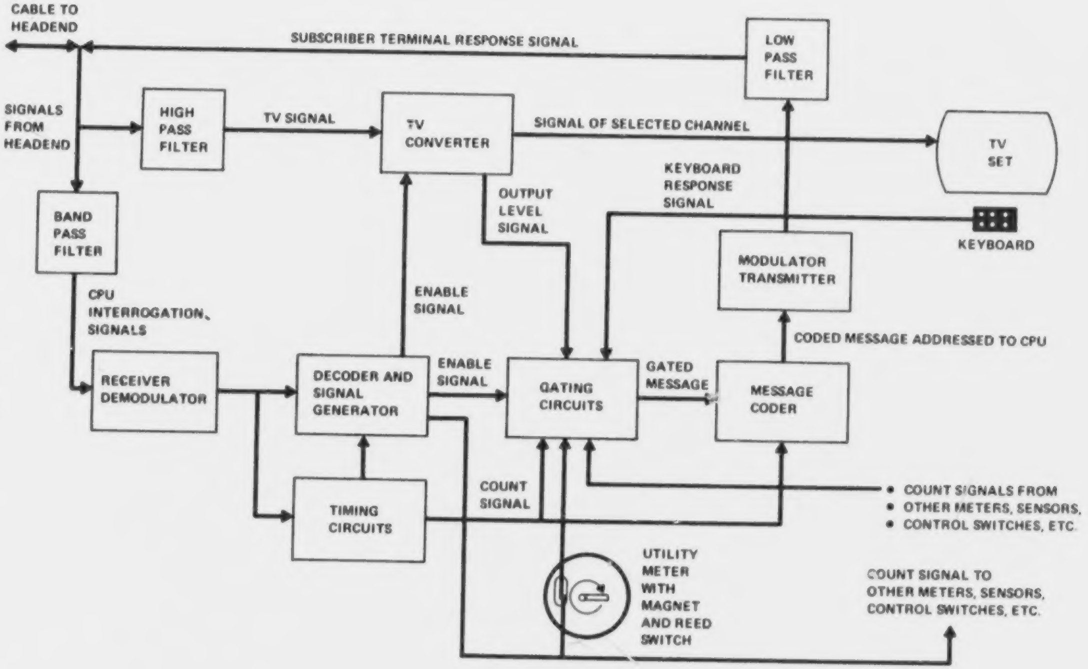

FIGURE VIII-1
DEMONSTRATION OF COMBINED SUBSCRIBER RESPONSE
AND AUTOMATIC SENSOR INTERROGATION SYSTEM

PHASE III - DEMONSTRATION AND ANALYSIS (6 Months)

- Operate demonstration and record data.
- Analyze results of demonstration
- Analyze the impact of the demonstration system on other sensor interrogation services

Demand and Impact Studies

Cost-benefit analyses, designed to determine the amount that utility and maintenance companies and other potential subscribers would be willing to pay for these services, would be based on data gathered during the course of the demonstration. Included in this analysis would be a consideration of the possible impact of automatic sensor interrogation on other types of sensor interrogation services such as manual meter reading, and current types of burglar and fire alarm system.

Cost of Demonstration

The following summarizes the estimated cost of a demonstration and cost benefit study for Subscriber Polling and Automatic Sensor Interrogation services. This demonstration will provide operational experience with polling and automatic sensor interrogation services. This three phase program consists of a study phase, an installation phase and data gathering phase over a 15 month program which costs $1,316,000.

Schedule:
3 month study and planning
6 months installation of 1000 terminals
6 months data gathering

study and planning	$ 20K
engineering	20K
installation	50K*
terminals and sensors	750K*
computer rental and software	160K*
wideband cable rental	96K*
operating and maintenance	20K
cost benefit study	200K
	$1,316K

This demonstration can be phased in wherever limited two-way service becomes available. It is suggested that this demonstration be started at the end of the first year or concurrent with Implementation Phase 2 of the WCS.

ELECTRONIC INFORMATION HANDLING SERVICES DEMONSTRATION

Interactive Educational Television

Purpose

Currently in the District of Columbia, the vocational education programs for high school students and adults appear to be inadequate. Many more secondary students apply for vocational education every year than can be placed in vocational schools. The facilities, equipment, and materials in the vocational schools are frequently inadequate and out-dated.[3] Another problem is that of extending continuing vocational education to those who have completed a high school or junior college vocational program. A third problem lies in getting into the community and reaching the underemployed and unemployed with appropriate training programs.

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*These costs would not be incurred in a demonstration program on the WCS. The design and financial analyses for the WCS have included hardware and software cost to cover these items.

[3] Passow, Harry A., "Toward Creating a Model Urban School System: A Study of the Washington, D.C. Public Schools," Teachers College Columbia University, New York, New York, September 1967.

The D.C. Public School System is now making major revisions in its vocational education program in order to make the program more relevant to student demands and to establish closer ties between the schools, their curriculum, and the community.[4] Washington Technical Institute (WTI), for instance, employs a large staff to go into the community to recruit both incoming and former students.

The purpose of this demonstration is to test whether two-way vocational training programs provided by an Electronic Information Handling System, with or without CAI, for homes, vocational schools, and junior and senior high schools could improve the effectiveness or decrease the cost of providing this type of education. An associated market survey would be used to determine the acceptability of these courses at the prices required for economic viability. WTI already utilizes a substantial number of teaching machines and is wired for CCTV. This demonstration would seek to build on that base and extend the capability to other schools and to homes throughout the city. Potential funding and participation could come, for the case of Washington, D.C., from the D.C School System Department of Vocational Education, Vocational Rehabilitation Administration, Office of the D.C. Manpower Administrator, and Office of Youth Opportunity

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[4] "A Plan for Career Development in the D.C. Public Schools of the District of Columbia," Task Force on Vocational Education, May 1969.

Services. Washington Technical Institute and the Department of Vocational Education could take the lead in specifying the scope of the demonstration and designating the sites that would be provided with terminals, while the other agencies could contribute to program development and courseware. For other urban areas, similar institutions would be involved. A work program would contain the following tasks:

- Select the courses to be televised by each mode (i.e., using conventional TV or frame-stopper terminals)*
- Issue a contract for development of courseware
- Develop testing and monitoring procedures to evaluate student progress
- Determine administrative relationship between televised courses and regular school courses
- Develop evaluation procedures for teaching effectiveness of the medium including cost effectiveness for long-term sustaining operations.
- Conduct a suitable marketing survey to determine the acceptability of the courses at the fee required for economic viability

Description

Selected vocational courses would be cablecast from the headend studio into homes and schools in S/A's 2 and 7 of the WCS. While almost all areas of Washington have a need for more vocational education programs, Service Areas 2 and 7 present a broad cross-section of social, economic, racial, and ethnic groups (including a large Spanish-speaking population in S/A 7) in which to test such a program.

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*A subscriber response system could accomplish some of the tasks listed here, but in less depth than could be accomplished by an electronic information handling system. This particular demonstration does not consider SRS alone but the greater capability of EIH which includes SRS capability.

This demonstration project proposes the use of a lecturer who could use teaching aids such as films, filmstrips, a blackboard, etc., in giving his lesson and could query students at any time. He would receive an immediate composite feedback from the students and could modify his lecture to meet their needs during the course of the program. Alternatively, with the use of a frame-stopper terminal as provided by the MITRE TICCIT system (see Appendix B), a larger number of lectures using chalk-talk techniques could be sent to a number of classrooms over a single channel of the cable, as shown in Figure VIII-2. For example, with TICCIT sending one picture of the blackboard every 3 seconds in a television frame, up to 180 separate chalk-talk lectures of this type would be carried over a single cable channel for distribution to classrooms using frame stoppers.

The system proposed in this demonstration would use two-way experimental polling terminals and frame-stopping terminals. The terminals would be placed in the vocational, junior, and senior high schools and in various homes of students enrolled in vocational programs. The vocational programs would be cablecast to the schools and residences via the telecasting network.

Both Washington Technical Institute and the D.C. Public School System, Department of Vocational Education are very interested in developing educational programs of an interactive nature. Development

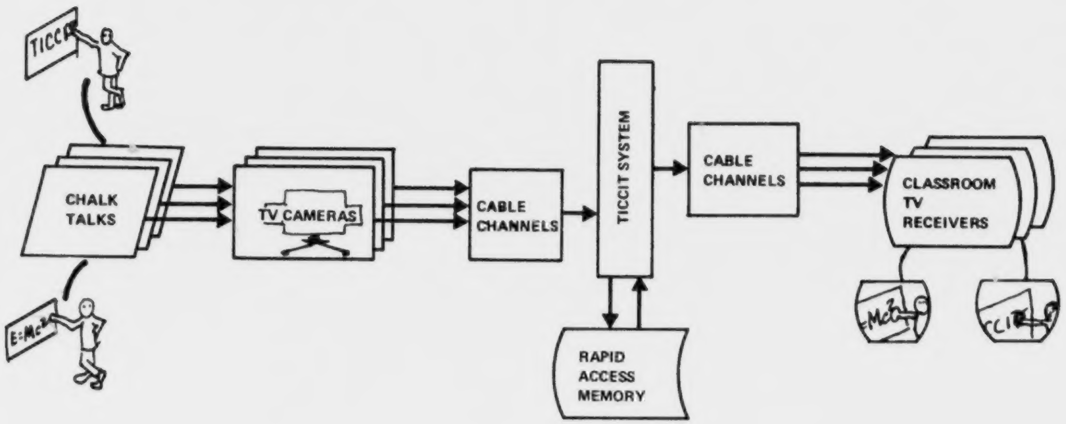

FIGURE VIII-2
INTERACTIVE EDUCATIONAL TELEVISION

of demonstration courseware could be accomplished through a joint effort or separately. It is suggested that four courses be developed, including courses for both direct instruction in a particular subject area and for supplemental instructions, such as job socialization to give students a more realistic view of various types of working environments that they might encounter. Since there is such a large Spanish-speaking population in S/A 7, it is proposed that at least one course, if not all four courses, would be conducted in Spanish, as well as English.

A comprehensive survey of demand as a function of projected subscriber fees is necessary for this demonstration as well as a thorough evaluation of the effectiveness of the project including a follow-up study to determine whether courses helped trainees get jobs, helped them stay on the job, etc. A careful comparison of the cost and effectiveness of two-way versus one-way instructional television should also be made.

Cost of Demonstration

The following summarizes the estimated cost of a demonstration and cost benefit analysis for Interactive Educational Television Services. This demonstration will provide for the development of courseware and software to conduct experiments with two-way interactive educational television services. The 42-month program, which costs $2205K, consists of study, design, installation and data gathering phases.

Schedule: 12 months of study and planning
6 months of installation hardware
(continuing software development)
24 months data gathering

. study and planning	$ 40K
. terminal and computer hardware engineering	160K
. 200 terminals installation	30K**
. 200 terminals hardware	300K**
. computer purchase	300K**
. channel leasing	175K**
. systems software	400K
. interactive courseware	400K
. video taped lectures	200K*
. evaluation (cost benefit analysis)	200K
TOTAL COST	$2,205K

Phasing of this demonstration would be accomplished when both service areas 2 and 7 of the distribution network and required EIH Terminals are available. It will take almost two years to prepare the hardware and software. It would appear, therefore, the best time to start this project would be about the end of the second year.

SPECIAL SERVICES DEMONSTRATION

Automatic Vehicle Monitoring (AVM)

Purpose

An AVM System reports the location of every member of a set of

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[*] NOTE: The CAI courses would be less complex than TICCIT courses in terms of branching, etc. There would be considerable straight lecturing (80%). Each of four courses would cost $50,000 to produce: 120 hours (3 per week x 40 weeks) with ten preparation hours (at $40 per hour) per lesson hour. TICCIT system software would be used as needed for interaction portions.

[**] For the case of the WCS, costs for these items have been included in the financial analyses.

moving vehicles,[5] and can be used to enhance the operations of mass transit, police, taxis, ambulances, trucks, and other fleet operations. The mobile units transmit their own identification at low power output on a repetitive basis. This signal is received by the close-by fixed-site receivers, which in turn relay their location as well as the vehicle identification to a central control computer.

The uses of AVM are:

1) real time monitoring and dispatching of police and emergency vehicles.
2) dynamic scheduling and routing of transit vehicles
3) monitoring of conditions on board transit vehicles and reporting of private vehicle breakdown
4) tracing of vehicles stolen from a fleet covered by AVM (e.g., hijack protection)
5) controlling access to specified areas within each urban region.

Additional uses of AVM are discussed in References 6 and 7.

AVM Systems will be part of the operational capabilities of many large cities. The Urban Mass Transit Administration of the U.S. Department of Transportation has funded the demonstration of four different types of AVM systems for operational evaluation in Philadelphia from the Fall of 1971 through the Spring of 1972.

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[5] An Analytic and Experimental Evaluation of Alternative Methods for AVM, The Institute of Public Administration and Teknekron, Inc., July 1968, PB 180116 (Scientific Clearinghouse).

[6] Bales, R. A., "A Police Car Simulation Model," The MITRE Corporation, M70-3, February 1970.

[7] Gould, A. V., "Automatic Vehicle Monitoring," EASCON 1970.

This demonstration is designed to prove out the communications hardware and software that would be developed for utilizing AVM in conjunction with cable. For example, new interfaces will be developed to use the wideband capability of cable; some AVM techniques that had been considered in the past which employ fast rise-time pulses (large bandwidths) may become attractive for use with cable. This demonstration would result in a demonstration of the feasibility of using wideband cable for collection and distribution of AVM signals. It would also provide cost estimates for comparison with other methods of data collection. Thus, this demonstration would test out the AVM techniques as applied to cable. The demonstration is not a test of AVM.

Description

The demonstration would be designed to use the two-way capability of the second cable of the WCS to interconnect many streetside sensors. A preliminary description of such a system is contained in Reference 8. A conceptual diagram of the demonstration system that would be used in Figure VIII-3. The mobile units, each transmitting its own code, would be located within the test area by receivers located in a grid of about eight by eight to the square mile. These street corner receivers would identify the vehicle by its code and would add the

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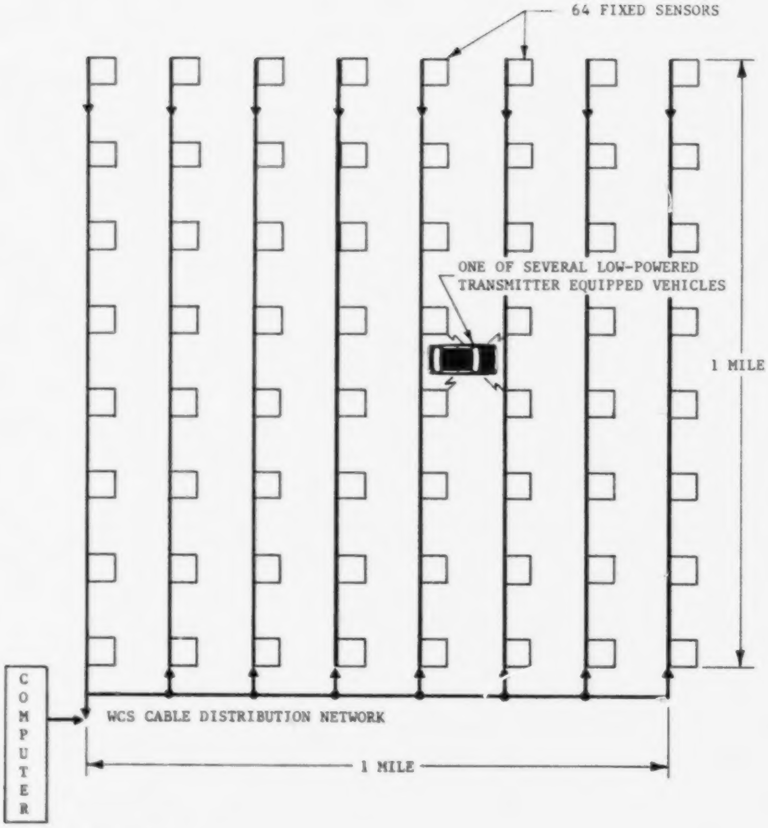
[8] Labonte, R. C., and Margulies, A. S., "Urban Mobile Communications and Vehicle Location Via Broadband Cable Networks," The MITRE Corporation, M71-110, Washington, D.C., December 1971.


64 FIXED SENSORS
ONE OF SEVERAL LOW-POWERED TRANSMITTER EQUIPPED VEHICLES
1 MILE
COMPUTER
WCS CABLE DISTRIBUTION NETWORK
1 MILE

COMPUTER FUNCTIONS:

1) POLLING ALL FIXED SENSORS
2) RECEIVING AND STORING ALL VEHICLE IDENTIFICATION AND FIXED SENSOR LOCATIONS
3) DISPLAYING VEHICLE LOCATIONS ON DISPLAY BOARD OR BY HAND COPY PRINTOUT

FIGURE VIII-3
AUTOMATIC VEHICLE MONITORING (AVM) DEMONSTRATION SYSTEM

receiver location code to the message being transmitted back to the computerized central location by broadband cable.

The cars contain low power transmitters that radiate distinctive signals, to the receivers. This concept, called an "electronic license plate" could enable a large number of vehicles to be located.

Cost of Demonstration

The following summarizes the estimated cost of a demonstration and evaluation for Special Services. This demonstration provides for an experimental cell one mile square which uses 64 fixed sensor locations and 5 vehicle transponder/transceivers. The three phase program of study, installation and data gathering runs a total of 18 months at a total cost of $445,000.

Schedule:
6 months study and planning
3 months installation
6 months data gathering
3 months evaluation

• study planning	$ 20K
• engineering	50K
• installation	4K
• hardware	89K
• computer rental	15K*
• channel leasing	72K*
• system software	125K*
• operating and maintenance of AVM hardware	20K*
• evaluation	50K
TOTAL COST	$445K

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[*] These costs would not be incurred in a demonstration on the WCS as these costs have been included in the base cases analyzed in the financial analyses.

This demonstration would be performed in Service Area 5, 6, or 7 starting near the end of the second year of the overall implementation schedule.

POINT-TO-POINT SERVICES DEMONSTRATION

Health Care Delivery

Purpose

The inadequate availability of health services in central cities has become a prominent medical issue. Table A-2 documents the need for improved health care in Washington, D.C., particularly in the inner city. A number of experiments have demonstrated in a limited context the medical feasibility of utilizing closed circuit TV to connect medical facilities for diagnostic, consultative and educational purposes.[9, 10] To date, experiments have been conducted on a limited scale for specialized applications. A medium-scale demonstration, interconnecting a number of hospitals and community health care centers, would help to determine the extent to which technology can ease some of the problems of making health care more accessible to inner city residents. Such a demonstration could answer questions pertaining to: feasibility of remote medical diagnosis and referral on an operational basis; the effectiveness and cost of such an approach; the rate at

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[9] Raymond Murphy, et al., "Tele-Diagnosis: A New Community Health Resource," Massachusetts General Hospital, USPHS Project #CH23-41AG, undatec

[10] Aims McGuinnes, et al., "The Medical Television Audience of the New York Academy of Medicine After Four Years," Bulletin of the New York Academy of Medicine, Vol. 44, No. 3, March 1968.

which patients could be handled by such a system; the acceptability to the public and the medical profession of the techniques used; types of medical personnel needed; the number of patients served; cost per patient; new midical services provided; and savings produced by operating on a preventive rather than a curative basis.

For the case of Washington, D.C., the Office of Planning in the Department of Human Resources would be the logical agency to take the lead in developing and implementing this demonstration and market survey. A project task force could be composed of the Hospitals and Medical Care Administration, Mental Health Administration, Community Health Services Administration and the Narcotics Treatment Administration. Suggested tasks would include:

- Determine participant agencies and sites
- Define demonstration objectives, evaluation techniques and procedures
- Identify medical team/technology mix
- Evaluate impact of demonstration on conventional delivery system

Description

An initial configuration of seven two-way point-to-point cable links between two hospital centers and seven remote health care facilities is proposed. If the demonstration proves successful and evaluation indicates public acceptability of this types of health care delivery, the system could be extended to include clinics and other health facilities throughout the city. Another concept which could be tested by this demonstration is that of a medical information network which would provide for the storage and retrieval of patient records as well as analysis of these records for medical research. In addition, educational materials could also be disseminated by the system among hospitals and satellite clinics. The need for public education concerning self-maintenance, in cases such as diabetics, cardiac conditions and physically handicapped could also be satisfied by such a network. Specialists within the hospitals could provide both initial training and refresher courses for out-patients as well as for the medical staff. Figure VIII-4 shows a conceptual diagram of the type of system that would be used for the health care delivery demonstration.

Cost of Demonstration

The following summarizes the estimated cost of a demonstration and evaluation which provides expanded availability of health care services through the interconnection of two hospitals and seven neighborhood medical clinics. The $437,000 program runs 30 months. These costs do not include the salaries of medical personnel.

Schedule: 3 months of study & planning
3 months of installation and checkout
24 months of data gathering

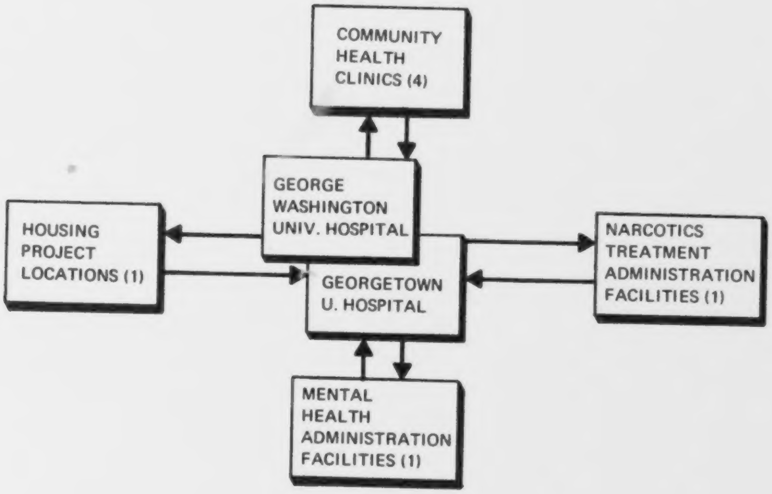
COMMUNITY HEALTH CLINICS (4)
GEORGE WASHINGTON UNIV. HOSPITAL
HOUSING PROJECT LOCATIONS (1)
GEORGETOWN U. HOSPITAL
NARCOTICS TREATMENT ADMINISTRATION FACILITIES (1)
MENTAL HEALTH ADMINISTRATION FACILITIES (1)

FIGURE VIII-4
HEALTH CARE DELIVERY DEMONSTRATION SYSTEM

- 7 two-way cable links between 2 hospital centers and 7 remote health care facilities
- 4 types of remote facilities

  4 community health clinics - full medical package

  1 mental health center - two remote cameras and monitor

  1 drug treatment center - two remote cameras and monitor

  1 housing project station - two remote cameras and monitor
- Each center contains required communications gear to transmit and receive

. study and planning	$ 20K
. engineering	10K
. special medical terminals	195K
. installation	10K
. operation and maintenance	80K
. channel leasing	92K*
. evaluation	30K
TOTAL COST	$437K

The health services delivery demonstration would be phased into operation at the beginning of the third year of WCS implementation.

Figure VIII-5 summarizes the schedules and phasing of some specific examples of demonstrations of various types of cable services that could be provided the WCS urban cable system. The costs indicated are those for separate unrelated demonstrations; costs would be considerably less if all demos were done on a single system, such as the WCS. No attempt has been made to define a comprehensive list of all the cable services that could be provided. Certainly, many of the other services listed in Table III-1 could be demonstrated in Washington, D. C., and other urban areas using either existing cable systems of UHF stations or some portion of a new urban cable system as it is being implemented.

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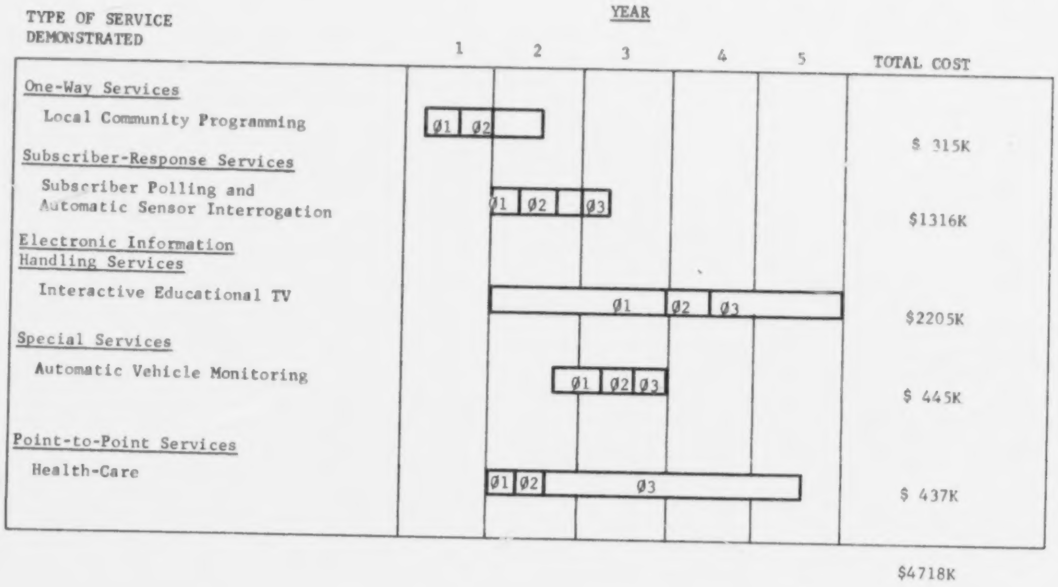
[*] These costs would not be incurred in a demonstration on the WCS, as these costs have been included in the base cases analyzed in the financial analyses.

FIGURE VIII-5
PROGRAM FOR TYPICAL DEMONSTRATIONS ON WCS



APPENDIX A

CHARACTERISTICS OF WASHINGTON, D. C.

INTRODUCTION

In order to design a telecommunications cable system that is relevant to the needs and problems of the residents and institutions of the District of Columbia, it is important to investigate the demographic, political, governmental, commercial, social, economic, and physical characteristics of the capital city. This section provides the statistical information required to support various phases of the WCS design procedure. By its nature this section tends to highlight many of the problem areas which confront the District; this was done to show how broadband communications can be used to address some of these problems. No effort has been made to project this data over the next decade.

Section III discusses the new services that a telecommunications cable system can provide to meet certain of the informational and communications needs of the city described in this section as well as to provide an expanded choice of entertainment through innovative programming.

OVERVIEW OF WASHINGTON, D. C.[1]

Washington, D. C. is the ninth largest city in the United States and is the central city of one of the most rapidly growing metropolitan areas in the country. Its total area is 61 square miles with an average population density of 7,011 per square mile. The total population of the city recorded by the 1970 census was 756,510 and the median income $8,835. The median age of the D. C. population is 29 years. In 1971, the annual average unemployment rate of the city was 2.9%.[2] As the national capital and seat of the Federal government, Washington is a leading national and international center. Its numerous universities, museums and galleries, as well as the new Kennedy Center for the Performing Arts, make it a center of culture and tourism.

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[1] See Table A-2 for sources of statistics except where noted.

On the other hand, a high crime rate, a substantial drug addiction problem, below norm performance in the public schools, a large inventory of deteriorating housing and inadequate health care delivery, all common problems in urban areas as shown below, are some of the major difficulties faced by Washington at this time. Lack of mass transit contributes to the traffic congestion of the downtown area. The out-migration of middle-income families to the suburbs has been followed by many retail and merchandising establishments as well as office complexes. This flight to the suburbs, typical of so many American cities, weakens the central city tax base without substantially decreasing the need for municipal services. The governmental structure in Washington is extremely complex. The source of power, authority, and responsibility does not lie in any one governmental structure but is spread among the

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[2] Preliminary estimate from U. S. Department of Labor, Bureau of Labor Statistics, D. C. Area Analyst.

Municipal Government, the Federal Executive Branch, Federal agencies, and most prominently, the Congress.

COMPARISON OF WASHINGTON, D. C. TO OTHER MAJOR U. S. CITIES

In recent years, much attention and publicity has been focused on the problems of American cities. Washington, D. C., because of its high visibility as the Federal city and a national showplace, is often cited as an illustrative example of a city with serious urban problems and an inadequate quality-of-life standard.

While Washington is often used to illustrate the problems of urban America, it is helpful to compare this city with other urban areas to gain perspective on the degree and intensity of these problems. Table A-1 provides a list of selected indicators comparing this capital city with other major cities. It should be noted that this is not a complete set of quality-of-life indicators and should not be used to make overall generalizations in comparing these cities. These statistics are provided primarily to give perspective to the problems of Washington, D. C.

Washington is the only city listed with a majority black population. For both blacks and whites, the median school years completed for D. C. residents compares favorably with other cities. Washington has a lower percentage of low income households as compared to the other cities. Retail sales per population are high; mean household income is high; and the unemployment rate compares favorably with that of other cities. The crime rate is relatively high for D. C. as compared to the other cities.

TABLE A-1
INDICATORS FOR 13 URBAN AREAS (CENTRAL CITY ONLY)

CITY	TOTAL POPULATION[3]	ESTIMATED % BLACK[4]
New York	7,969,500	20
Los Angeles/Long Beach	3,223,730	18
Chicago	3,475,650	30
Philadelphia	2,027,760	30
Detroit	1,609,530	40
Minneapolis/St. Paul	737,440	5
Milwaukee	752,640	15
Dallas	817,040	20
Houston	1,157.540	20
Washington,D.C.	825,000	70
Baltimore	910,800	40
St. Louis	674,540	35
San Francisco/Oakland	1,079,640	15

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[3] "Estimates of Population of 100 Large Metropolitan Areas," U.S. Bureau of the Census Series P-25, No. 432, Oct. 3, 1969.

[4] Estimated on the basis of migratory trends. U.S. Statistical Abstract, 1970.

TABLE A-1 (Continued)

CITY	MEDIAN SCHOOL YRS. (1968)[5] COMPLETED			% LOW INCOME[6] HOUSEHOLDS	CRIME RATE PER 1,000[7] POPULATION 1968
	Total	White	Black		
New York	11.6	11.8	10.7	16	60.6
Los Angeles/Long Beach	12.4	12.5	12.1	20	55.5
Chicago	11.4	11.8	10.7	15	34.4
Philadelphia	11.2	11.5	10.6	19	16.5
Detroit	10.9	11.1	10.5	14	58.8
Minneapolis/St. Paul	12.2	12.2	NA	17	49.6
Milwaukee	11.5	11.6	NA	13	23.0
Dallas	12.4	12.5	NA	17	29.6
Houston	12.3	12.4	11.1	18	41.4
Washington, D.C.	12.0	12.7	11.0	15	59.8
Baltimore	9.9	10.9	8.5	21	73.7
St. Louis	9.6	9.5	9.7	24	57.9
San Francisco/Oakland	12.3	12.5	11.5	21	69.9

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[5] "Population Characteristics, "Current Population Reports, Series P-20, No. 209, Jan. 8, 1971, U.S. Bureau of the Census, Department of Commerce, Washington, D.C.

[6] U.S. Bureau of the Census Series P-25, op.cit.

[7] "Crime in the United States," Uniform Crime Report-1968, FBI, Washington, D.C.

TABLE A-1 (Concluded)

CITY	UNEMPLOYMENT RATE (1970)[8]			RETAIL SALES[9] 1967 ($1,000)	MEAN HOUSEHOLD[10] INCOME (1969)
	Total	White	Black		
New York	4.8	4.7	5.4	11,762,143	10,227
Los Angeles/Long Beach	8.4	8.2	9.8	5,801,528	11,060
Chicago	4.0	3.5	5.3	5,829,871	10,775
Philadelphia	5.3	4.5	6.9	2,748,382	9,362
Detroit	8.2	6.1	11.9	2,500,308	10,886
Minneapolis/St.Paul	6.7	6.4	NA	1,483,894	10,388
Milwaukee	5.0	4.3	NA	1,241,105	10,996
Dallas	3.9	2.8	8.6	1,678,409	11,109
Houston	3.8	2.5	7.5	2,209,727	5,680
Washington, D.C.	4.9	4.4	5.1	1,565,544	11,625
Baltimore	4.7	3.9	5.4	1,476,595	8,893
St. Louis	6.5	3.9	9.9	1,171,958	8,135
San Francisco/Oakland	7.3	7.2	7.3	2,377,143	10,015

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[8] Manpower Report of the President, op.cit.

[9] "Major Retail Centers," 1967 Census of Business, Bureau of the Census, U.S. Department of Commerce, BC67-MRC-1, Dec. 1970.

[10] "1970 Survey of Buying Power," Sales Management.

SERVICE AREA SYSTEM

While city-wide averages and other statistics are useful for general description and comparison purposes, more detailed data is needed for the design of a communications system that will directly serve each street and neighborhood. The District, as all major cities, is comprised of many diverse and discrete interest groups covering a broad range of social and economic levels, ethnic groups, and other special interest categories. In addition, the need for services is not uniform throughout the city. In order to assess the wide variety of educational, informational, communications and entertainment programming of these special interest and localized groups, it is necessary to try to identify what these groups are and where they are located. This identification will not only be useful in suggesting types of programming but can also serve as one basis for locating WCS local origination studies and facilities.

Washington has been divided into nine separate administrative Service Areas in an effort to simplify the delivery of municipal services and to be more representative of, and more responsive to, the citizens residing within the city. The activities of all Municipal departments and Federally-sponsored programs for being planned, coordinated and administered through this Service Area system.

The criteria used for delineating these areas were man-made barriers, natural boundaries, neighborhoods, community organizations, existing agency boundaries and the Model Cities area. The resulting Service Areas can be roughly separated into three groups based on similar demographic, social, and economic indicators. S/As 1, 2, and 8 are the most affluent sections of the city containing the upper-income and middle-income residential areas. S/As 3, 4, and 9 are the transitional groupings in terms of the distribution of Washington's quality-of-life. S/As 5, 6 and 7 form the core city area.

The Community Service Division of the Office of Planning and Management (D. C. Government) administers the Service Area system. Community Service Advisory Committees are currently working toward developing S/A identity and are conducting studies of the physical, demographic, social, and economic characteristics of each particular area in order to better serve their needs. One of the crucial problems in developing these infrastructures is the lack of a local communications medium through which to involve the residents of each particular Service Area in community development programs. Cable could provide programming to directly service the needs and interests of small and localized groups (such as those that exist within the Service Areas) and, especially through interactive services, could provide the communications medium needed for citizen involvement in community programs.

Since the Service Areas are quite socially and economically homogenous and represent the official administrative structure of the District government, these Service Areas present a logical set of boundaries along which to partition a cable system designed to serve local interests and needs. This cable system will also be able to interconnect any groupings of Service Areas thus increasing communication between a wide variety of groups living in different parts of the city.

Table A-2 provides selected indicators by Service Areas; these data are pertinent to the design of this system. It should be noted that the highest density areas (S/As 5, 6, and 7) are also the lowest income areas. S/As 8 and 9 are the poorest reception areas with middle to high incomes; Areas 3, 4, 5, and 6 have large public school populations. Area 9 contains the overwhelming majority of Federal, D. C. and public office buildings as well as the Central Business District.

Table A-2 shows that the median family income for D. C. is $8,835, as compared with the national figure of about $9,500. However, in four (3, 4, 6, and 7) of the nine Service Areas, the median is more than $1,000 below that of the District, while in S/A 8 the median is $7,000 above.

The median age District-wide is 28.9 years--for S/A 4 it is only 22.5 years while for S/A 8 it is 40.9 years. Approximately 45% of the population in S/As 3 and 4 is under 20 years of age. In S/A 4, 39.4% of all children under 18 are 6 years or younger.

Areas 5, 6, and 7 contain approximately 60% of the total number of public assistance recipients and 35% of the total population. Areas 3, 5, and 6 have the lowest average monthly rent as well as

TABLE A-2
SELECTED STATISTICAL DESCRIPTION OF WASHINGTON, D.C.

ITEM	SERVICE AREA									AVERAGE OR TOTAL
	1	2	3	4	5	6	7	8	9	
POPULATION:[11]										
Households	25,076	16,135	26,827	37,327	22,836	26,680	42,860	41,108	21,957	262,786
Population	79,142	54,052	89,449	126,239	71,062	79,157	11[illegible],401	99,597	41,413	756,510
Average Number of Persons Per Household	[illegible]	3.3	3.3	3.4	3.2	3.0	2.7	2.3	1.9	2.8
Population Density Per Square Mile[12]	12,322	12,163	7,636	13,286	12,437	16,537	29,908	27,333	5,888	7,011
POPULATION DISTRIBUTION										
Percentage of Population Black[13]	82.0	83.5	96.2	85.1	83.2	90.4	76.4	2.6	28.6	71.1
Median Age[14]	32.8	29.2	23.4	22.5	27.3	29.9	30.8	40.9	32.6	28.9
Percent of Population 20 Yrs. and Under[15]	33.1	37.7	45.9	45.0	39.6	37.1	31.0	22.9	23.6	35.1
Percent of Juvenile Population 6 Yrs. and Over[16]	27.5	26.8	31.3	39.4	29.2	29.5	34.0	29.9	33.7	31.3
Percent of Population 64 Yrs. and Over[17]	9.5	6.7	3.2	4.0	7.1	7.5	10.8	15.8	14.0	9.4
INCOME:										
Median Family Income[18]	10,694	9,553	7,525	7,613	7,999	6,294	7,225	15,922	9,039	8,835
EDUCATION:										
Elementary Schools	15	10	21	25	20	24	17	14	11	157
Elementary Enrollment[19]	9,533	7,093	16,007	18,354	12,126	13,369	9,693	4,119	3,677	93,971
Per Pupil Expend. (Elementary)[20]	$405.	$394.	$397.	$387	$349	$419	$4[illegible]	$427	$487	$408
Secondary Schools	6	2	7	7	7	6	6	4	3	48
Secondary Enrollment[21]	7,140	1,970	5,501	7,061	8,506	4,631	6,265	5,066	2,388	48,306
Per Pupil Expend. (Secondary)[22]	$667	$611	$598	$606	$606	$759	$768	$704	$624	$694
SOCIO-ECONOMIC										
Public Assistance Recipients[23]	2,822	1,588	8,687	10,367	8,929	12,922	11,028	226	2,288	58,857
Food Stamp Program Participants[24]	1,887	1,698	10,379	13,337	9,625	13,022	11,135	189	1,637	62,909
Average Monthly Rent[25]	120	112	101	112	100	97	110	182	152	121
Percentage of Units Renting for Under $80/mo.[26]	8.7	16.0	26.3	14.0	35.9	41.6	21.5	2.5	14.0	20.0
HEALTH (1968)[27]										
Percent of Births With Inadequate or No Prenatal Care	18.4	19.3	24.1	20.7	27.4	30.7	27.8	6.2	21.1	23.1
Infant Deaths Per 1,000 Live Births										
Negro	32.3	21.5	33.5	35.8	33.0	40.3	33.4	0	12.0	33.7
White	15.0	0	***	16.9	23.1	0	15.6	16.2	45.5	21.8

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[11] Trends, D.C. Department of Human Resources, Vol. 2, No. 1, June 1971.

[12] "Demographic, Social, and Health Characteristics of the Residents of the District by Service Areas," D.C. Department of Human Resources, February 1971, page 16.

[13] Trends, June 1971, op. cit.

[14] Ibid.

[15] Westat Research Corporation.

[16] Ibid.

[17] Ibid.

[18] Ibid. D.C. median income is estimated from a weighted average of the medians for all S/As.

[19] Trends, June 1971, op. cit.

[20] "Demographic, Social, and Health Characteristics of the Residents of the District by Service Areas," op. cit.

[21] Trends, June 1971, op. cit.

[22] "Demographic, Social and Health Characteristics, ...," op. cit.

[23] Trends, Sept. 1970, op. cit.

[24] Ibid.

[25] Westat Research Corporation.

[26] Ibid.

[27] Trends, Sept. 1970, op. cit.

TABLE A-2 (Continued)

ITEM	SERVICE AREA 1	2	3	4	5	6	7	8	9	AVERAGE OR TOTAL
Deaths Per 100,000 Population	1158.9	857.1	747.3	596.8	1183.4	1519.4	1329.3	1433.1	1331.6	1151.6
New Active TB Cases Per 100,000 Population	47.9	27.8	40.7	31.6	60.7	116.6	77.2	14.0	84.2	55.9
New VD Cases Per 100,000 Population	1330.4	918.7	1734.5	1715.8	2618.3	3047.0	2554.5	168.8	1442.1	1871.2
Percentage of Families With Female Heads[28]	12.1	12.4	23.0	22.3	22.2	22.0	18.0	4.5	14.1	16.7
Percentage of Children in Families With No Father[29]	21.7	20.8	36.4	33.5	37.2	39.1	35.6	10.7	37.1	30.2
Percentage of Births Out-of-Wedlock (1968)[30]	28.7	23.9	34.6	23.9	43.4	49.4	39.9	6.6	71.7	33.3
Delinquency Referrals Per 1,000 Youths Under Age 18 (1969)[31]	9.7	11.0	13.1	13.1	13.3	20.6	15.5	3.5	10.5	13.5
Number of Addicts per 1,000 Population[32]	13.3	10.9	19.9	18.0	27.7	40.2	30.8	0.8	14.6	19.6
PUBLIC SERVICE FACILITIES:										
Hospitals	0	2	0	3	1	1	2	2	4	15
Police Stations	1	1	1	1	1	3	2	2	4	16
Fire Stations	1	3	2	4	3	3	5	5	10	36
TELEVISION OWNERSHIP:										
Households With TV Sets[33]	23,320	15,006	26,849	34,714	21,237	24,812	39,841	40,090	20,420	244,389
Households With Color TV Sets[34]	9,027	5,809	9,658	13,438	8,221	9,605	15,422	15,519	7,904	94,603
Households With More Than One TV Set[35]	10,532	6,777	11,267	15,677	9,591	11,206	17,993	18,105	9,222	110,370
HOUSING:[36]										
Total Housing Units	25,798	16,600	27,771	40,050	24,450	29,383	46,414	44,718	23,359	278,444
Single-Family Units	14,911	10,856	12,802	9,852	11,003	9,755	11,162	18,826	2,780	101,947
Units in Building With 2-4 Units	2,395	1,264	3,293	6,643	2,958	4,318	7,734	5,696	4,529	38,830
Units in Building With 5-9 Units	1,524	804	2,096	4,228	1,883	2,748	4,921	3,625	2,881	24,710
Units in Building With 10 or More Units	6,968	3,676	9,580	19,327	8,606	12,562	22,497	16,571	13,171	112,958
Vacancy Rates[37]	2.9	2.8	3.4	6.8	6.6	9.2	7.7	3.6	6.0	5.4
Percentage of Units Overcrowded[38]	7.7	8.5	17.8	17.7	16.6	19.5	13.8	2.0	7.5	12.3
Percentage of Children Living in Overcrowded Units[39]	28.1	29.8	48.1	46.9	53.7	63.0	53.7	9.1	46.6	42.1
Average Number of Rooms Per Unit[40]	5.3	5.2	4.5	4.1	4.4	3.6	3.5	4.7	2.7	4.2
Average Number of People Per Unit	3.2	3.3	3.3	3.4	3.2	3.0	2.7	2.3	1.9	2.9
OFFICE BUILDINGS:										
Government (D.C. and Federal)	1	0	0	0	4	2	5	2	153	167
Non-Government	0	0	0	1	7	1	1	2	43	55

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[28] Westat Research Corporation.

[29] Ibid.

[30] Trends, Sept. 1970, op. cit.

[31] Ibid.

[32] Press release, Dr. Robert L. DuPont, Feb. 4, 1971.

[33] Based on Nielson data of 93% of D.C. households having one or more TV sets.

[34] Based on American Research Bureau figure of 36% for D.C. households.

[35] Based on ARB figure of 42% for D.C. households.

[36] Housing units figures (except where noted) were supplied by the D.C. Demographic and Statistical Division. These data were given for total housing units only. S/A breakouts were estimated and are subject to change with the forthcoming 1970 Census count.

[37] Westat Research Corporation.

[38] Ibid.

[39] Ibid.

[40] Ibid.

the largest percentage of units renting for $80 per month or less. A significant percentage of the housing units in Areas 3, 4, 5, 6, and 7 are overcrowded. Even more significant are the large percentages of children living in overcrowded housing units in all areas except S/A 8.

Two health indicators are infant mortality rates and TB rates. For the U. S. as a whole, non-white infant deaths number 35.9 per 1,000, and the rate of white infant deaths is 19.7 per 1,000. Service Area 6 exceeds the national average with 40.3 deaths per 1,000, while the other areas (with the exception of 9) are generally somewhat better than the national average.[41] All areas with the exception of S/A 8 exceed the national rate of 21.3 reported new cases of TB per 100,000. Areas 5, 6, 7, and 9 have the highest TB rates, roughly from 3 to 5 times the national figure. Areas 5, 6, 7, the core city, have the highest figures for inadequate prenatal care, new cases of VD, delinquency and illegitimacy rates. Numbers of drug addiction cases are also highest in these areas.

These statistics provide many indications of the kinds of programming needed. For example, the population distribution statistics indicate that Area 4 requires a larger percentage of programming directed at pre-schoolers. The converse is true of Area 8 which contains the highest percentage of the population over 64 years.

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[41] Service Area 9 shows a surprising and unexplained rate of 45.5 infant deaths per 1,000 for the white population.

Statistics for Areas 3, 4, 5, 6, and 7 indicate a need for public assistance information programming. Statistics for Areas 3, 4, 5, 6, and 7 show a need for programs relating housing information in terms of where to locate better or larger housing facilities, what D. C. agency will help in finding new living quarters, how to get repairs, etc.

Areas 5, 6, and 7 need programming conveying health care information such as the availability of medical care facilities, costs, eligibility, etc. These areas could also be well served by an intensive drug prevention and treatment campaign via the cable.

A number of conditions exist on a city-wide basis. For example, achievement test scores of urban public school students are frequently publicized for falling below national norms. The national norm for reading in the Sequential Test of Educational Progress (STEP) is the 50th percentile. For D.C. fourth graders, it is 31st percentile; for sixth graders it is the 35th percentile. Math scores (again, national norm 50 percentile) for fourth graders is at the 25th percentile; for sixth graders it is the 29th percentile.[42]

Another area of concern is the decline of the central business district and the lack of an adequate system of rapid transit. Of over 600,000 workers in the District, approximately 54%[43] are commuters from adjacent Maryland and Virginia counties. These commuters daily pour in and out of Washington (mostly to S/A 9) by automobile through about 20 main arteries. The reliance on automobiles as the primary mode of commuting has led to a severe traffic congestion problem for Washington.

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[42] Jordan, Paul L., "Instructional Uses of Cable Television in Washington, D. C.," WN-7515-FF, Working Draft, The RAND Corporation, Santa Monica, California, July 1971.

Ninety-six percent of Washington's employment falls in the government and service[44] categories (only 4% fall in the "goods" category). They are both heavily dependent upon correspondence and the efficiency of the mail service. The Kappel Report[45] states that present mail service is not economically viable or efficient. The cost of mailing is turning many businesses to alternative methods of delivery.

While Washington did not suffer any serious power blackouts or brownouts in the summer of 1971, such possibilities exist in the future since power consumption demands are expected to double within the next ten years, while concern with environmental factors is slowing the rate of growth of new power generating capacity.

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[43] Telephone communication with Metropolitan Washington Council of Governments. Percentage is based on survey of commuting patterns from 1960-68 by COG.

[44] Statistical Abstract of the United States, 1970, U. S. Department of Commerce, Washington, D. C.

[45] Presidential Commission on Postal Organization, Toward Postal Excellence, June 1968, USGPO.

Another problem facing cities in general is health care delivery. In the District of Columbia, 23.1% of all births have inadequate or no prenatal care. The infant death rate (per 1,000 population) is 33.7 for blacks and 21.8 for whites. Another leading health indicator is the number of TB cases per 100,000 population. For the nation it is 31.3; for the District it is 55.9.[46]

Deteriorating and inadequate housing is another indicator of declining urban quality-of-life. More than one-half of the District's housing is over 30 years of age. Nine percent of the city's population lives in severely overcrowded housing. Home ownership, which insures control of the maintenance of the dwelling, has dropped from 32% in 1960 to 27% in 1970.[47]

High rates of crime and drug addiction characterize the inner city areas of many large cities. Washington officials state that the District is now in the midst of a drug addiction epidemic with a conservative estimate that 2.2% of the population is addicted. This addiction is concentrated almost exclusively among young adults (especially males) between the ages of 15 and 35. Sixty-seven percent of the addicts are under age 26. The core city area is the worst afflicted area with an addiction rate of 36% of the men between the ages of 20 and 24 and 24% of the boys between the ages of 15 and 19. Assuming an average habit cost of $40 per day, the annual value of property and services transferred because of addiction-robbery, theft, prostitution, drugs sales, etc.--is calculated to be $328,100,000.[48]

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[46] *Trends*; U.S. Averages from U.S. Public Health Service.

[47] *Metropolitan Bulletin*, Washington Center for Metropolitan Studies, Number 3, May 1971.

Employment in the District is fairly stable when compared with other urban areas because of the Federal government. Forty-nine percent of all jobs within the District are with the Federal or Municipal governments. While the rate of unemployment for the city was 4.9% in 1970, the inner city unemployment rate was 8.1% in that year. In addition, a study by Prof. Tella of Georgetown University suggests that because of "hidden unemployment" this rate may actually be much higher.

This section has presented a number of areas that could benefit from improved communications. Further discussion of potential applications of cable in the District of Columbia so that the quality of life may be improved is presented in Section III where the needs of Washington are further related to the services provided by cable.

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[48] Press release of Dr. Robert L. DuPont, "Profile of a Heroin Addiction Epidemic and an Initial Treatment Response," Narcotics Treatment Administration, Washington, D. C., February 4, 1971.

APPENDIX B

TECHNICAL ALTERNATIVES[1]

INTRODUCTION

This Appendix is provided for those not familiar with cable system technology. It discusses the system hardware and software alternatives that could be utilized to provide services for either telecasting systems (headend to subscriber) or point-to-point systems (subscriber-to-subscriber). In a telecasting or "hub" type system, signal flow from the headend to subscriber is spoken of as downstream or down; from subscriber to the headend as upstream or up. These services can be categorized as listed below:

- Telecasting Net
  - One-Way
    - Limited One-Way
    - Full One-Way
  - Two-Way
    - Limited Two-Way
      - Subscriber Response
      - Electronic Information-Handling
    - Special (e.g., traffic control and digital communications)
    - Full Two-Way
- Point-to-Point

Figure B-1 depicts a categorization of cable systems on the same basis.

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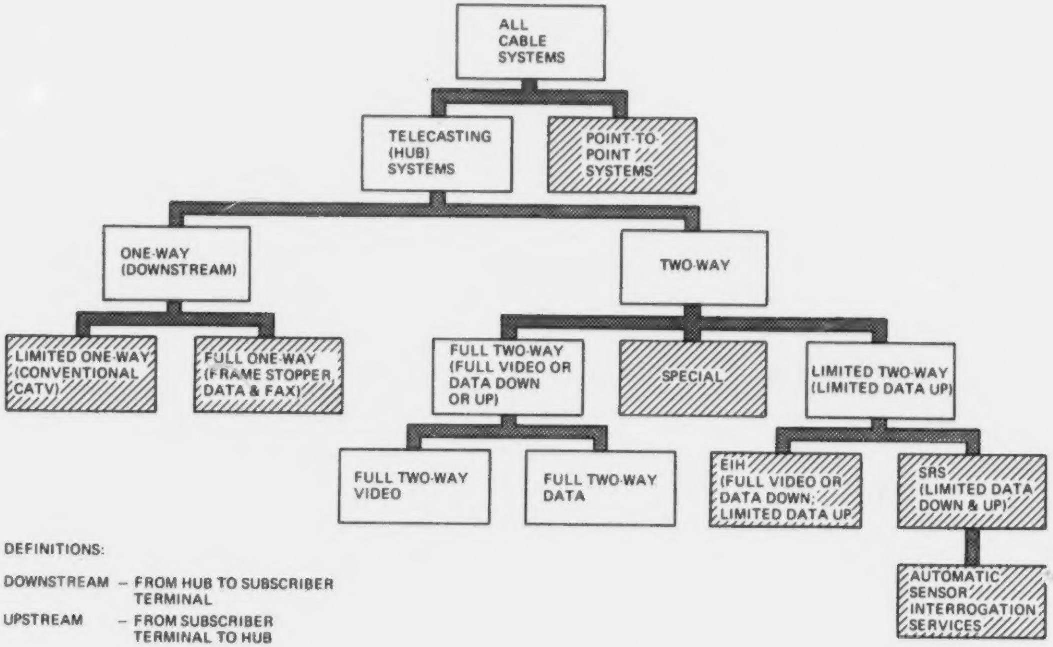
[1] Portions of this section pertaining to conventional cable television are based on the "Engineering Report on the Development of a Cable Television for Washington, D.C. to The MITRE Corporation" by Jansky & Bailey.


ALL CABLE SYSTEMS
TELECASTING (HUB) SYSTEMS
POINT-TO-POINT SYSTEMS
ONE-WAY (DOWNSTREAM)
TWO-WAY
LIMITED ONE-WAY (CONVENTIONAL CATV)
FULL ONE-WAY (FRAME STOPPER, DATA & FAX)
FULL TWO-WAY (FULL VIDEO OR DATA DOWN OR UP)
SPECIAL
LIMITED TWO-WAY (LIMITED DATA UP)
FULL TWO-WAY VIDEO
FULL TWO-WAY DATA
EIH (FULL VIDEO OR DATA DOWN; LIMITED DATA UP)
SRS (LIMITED DATA DOWN & UP)
AUTOMATIC SENSOR INTERROGATION SERVICES

DEFINITIONS:

DOWNSTREAM – FROM HUB TO SUBSCRIBER TERMINAL

UPSTREAM – FROM SUBSCRIBER TERMINAL TO HUB

FIGURE B-1
HIERARCHY OF CABLE TELEVISION SYSTEMS

The equipments available to provide each of the capabilities shown in Figure B-1 have been examined by MITRE.

Conventional one-way systems are referred to as "Limited One-Way" in this report. They carry conventional local and imported off-the-air signals, cablecasting signals and additional one-way programming and services such as mechanical services (time, temperature, etc.), local origination, innovative programs, instructional programs and one-way channels for lease.

The "full" one-way systems add frame-stopped video for facsimile capabilities to the limited one-way services. Such systems would have the two-way capability required by the March 31, 1972 FCC regulations. In the two-way category, limited two-way takes two forms. A subscriber response system carries short messages upstream from the subscriber to the headend. Here, data from a number of terminals may be collected and, if desired, a video response provided to subscribers over the conventional CATV channels. Thus subscribers can vote on issues or select purchases from those shown on the TV. In some cases, limited data messages for a particular subscriber can be sent on selected downstream channels. In addition, this type of system can be used for automatic sensor interrogation, so that meter reading and burglar alarm capabilities are available. In the class we refer to as electronic information-handling a unique address and a frame-stopper are provided for each terminal. In addition to the functions provided by the subscriber response system, the electronic information-handling system can transmit uniquely addressed video frames from the headend to any subscriber terminal. In this type of system, each channel is time-shared by a large number of subscribers.

The financial analyses described in Sections VI and VII are based on three combinations of these categories which we have referred to as One-Way Systems, Subscriber Response Systems and Electronic Information Handling Systems. These are defined as follows:

(1) One-Way Systems - Include all conventional one-way functions.

(2) Subscriber Response Systems - Include all functions of the one-way systems, plus the ability of a headend computer to discretely address each subscriber, and the ability of each subscriber to send a short digital message to the headend.

(3) Electronic Information-Handling Systems - Include all functions of the one-way systems, plus all functions of the subscriber response systems, plus the ability to receive discretely addressed, single frames of TV.

The terminal and computer costs used in the financial analyses are summarized in Table B-1. For the subscriber response system and electronic information-handling system, three different terminal costs were used in the sensitivity analyses. The programming costs for the EIH system are specially generous in that by the time EIH is introduced into the WCS other cable systems will be introducing EIH services. Thus, the WCS will not have to pay the programming costs of creating all of the EIH services for the first time.

TABLE B-1

TERMINAL AND COMPUTER COSTS USED IN FINANCIAL ANALYSIS

ONE-WAY SYSTEM	COSTS
Set-Top Converter	$27 per Terminal
Maintenance	3% on initial capital investment
SUBSCRIBER RESPONSE SYSTEM	
Set-Top Converter	$27 per Terminal
Subscriber Response Terminal	$100; $100/$150;* $250 per Terminal
5 Head-End Computers @ $150K each	$150K per system
Computer Programming	$750K per system
Maintenance	3% on initial capital investment
ELECTRONIC INFORMATION HANDLING SYSTEM	
Set-Top Converter	$27 per Terminal
Subscriber Response Terminal	$100 per Terminal
Electronic Information-Handling Terminal	$200; $300; $500 per Terminal
100 Head-End Computers @ $150K	$15M per system
Computer Programming $20 per subscriber year	$4M per system per year
Maintenance	3% initial capital investment and 3% per year on total capital investment

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*For those terminals that were used experimentally in the first few years, and extra $50 retrofit cost to update the terminal to reflect experience learned in experimentation was assumed; these terminals cost a total of $150.

SYSTEMS FOR CONVENTIONAL ONE-WAY SERVICES

Headend for Limited One-Way System

The master headend, and each subheadend,[2] must have a complement of equipments to receive off-the-air signals, to control, to change frequencies and to provide an interface between the off-the-air signals, the studio signals, any microwave signals from distant pick-up points, and the cable distribution system. The headend must include UHF and VHF antennas and amplifiers, video and FM channel processors, video modulators, filters and test equipment.

Imported signals[3] would be brought in from distant cities via a microwave system that would either be leased from a common carrier or owned by the cable system operator. The relay towers would be spaced at about 15 mile intervals with towers less than 200 feet tall. The microwave system would use the 10.7 and 11.7 GHz frequency bands. The headend would process these distant signals by changing their carrier frequencies to those of their assigned cable channels. They would then be distributed throughout the system either by trunk cable or by microwave air links.

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[2] Urban cable systems will generally be so large that more than one headend will be required to provide for suitable picture quality throughout the area served.

[3] Importation of distant signals is discussed in Cable Television Report and Order, FCC, February 3, 1972.

The master headend would use automatic origination equipment to provide such mechanical services as those for weather, news, radio, time, stock market reports, etc. Whether the hardware for mechanical services should be duplicated at the subheadends or whether the services should be transmitted to the subheadends depends upon the costs of interconnection between the subheadend and master headend in terms of channels available and their hourly costs. For the case of Washington, it is recommended that the mechanical services be duplicated at the subheadends. A number of manufacturers produce equipment for originating these mechanical services. Among the prime suppliers are Telemation of Salt Lake City, Utah, and Vikoa of Hoboken, New Jersey.

Generally, for mechanical services, both the time and weather, including barometric pressure, rainfall, temperature, relative humidity, wind direction and velocity, are provided through the use of a small motor driven camera that continuously scans a clock and a series of weather instrument dials. Both UPI and AP now have special wire services for news and stock market reports designed for use on cable systems. The AP-DATA VOX system, which is typical, uses video character generator equipment that is tied into the news wire, as well as delayed tickers of the New York Stock Exchange and the American Stock Exchange. Optionally, data from a local keyboard can also be provided. Either this local keyboard or a punched tape could be used to provide such special services as a TV channel guide and a summary of local events.

Local community programs would be originated both from local studios at or near the headends, and through the use of mobile units. Live programs would be originated or video tapes would be prepared for later cablecasting. A minimal studio for local origination would have a 30' by 40' floor space and would include a color camera, a one-inch helical scan video tape recorder, a processing amplifier, a switcher/fader, waveform monitor, amplifiers, sync generator, and other electronics, and would cost about $50,000. The minimal master studio would include much of the equipment of the minimal studio described above plus color cameras, a color film chain, routing switchers, and other equipment and would cost on the order of $100,000. A full professional studio would cost on the order of $600,000 to $1,000,000. Such studios are described by Jansky & Bailey in Chapters 17 and 18 of their report. A two-camera mobile unit would cost about $126,500, a one-camera unit about $76,500.

Interconnections for Limited One-Way System

Subheadends can be interconnected to the master headend by cable or by air links. Cable is usually "trunk" cable which is a 3/4" or 1/2" diameter cable. "Super-trunk" cable can also be used; it is 1-1/2" or 1" diameter cable. As shown in Table B-2, "super-trunk" has less loss per 100 feet than regular trunk cable so that fewer amplifiers per mile of cable are required. Typically, an amplifier is spaced every 22 dB of cable loss.

TABLE B-2

CABLE LOSSES AND COSTS[4]

SIZE	LOSS/100' AT CHANNEL 13 (216 MHz)	LARGE QUANTITY COST/1000'	
		PLAIN	JACKETED
.500" - polystyrene foam	1.07 dB	$112	$130
.750" - polystyrene foam	.72 dB	$245	$280
1.000" - polystyrene foam	.59 dB	$505	$585

Since signal distortion increases with each additional amplifier, "super-trunk" can provide a higher quality signal than regular trunk, although at greater cost.

Air links use both AM and FM modulation approaches. Conventional FM modulation schemes have been in use for a long time by the telephone companies and others. Local distribution service[5] (LDS) microwave is a new arrival which promises low cost interconnection capabilities for the cable television market. LDS microwave employing both AM and FM modulation schemes are being produced. Because the interconnect hops for cable television are shorter distances than those used in the telephone industry and require many video channels, LDS equipment is very cost competitive with conventional FM microwave. As shown in Section 16 of the Jansky & Bailey report, one channel of conventional FM costs more than 12 channels of LDS.

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[4] Our discussions with cable manufacturers.

[5] O'Neill, J. J., "Technical and Economic Investment of the Interconnection of WCTS's Multiple Headends, MITRE WP-8542, 16 November 1971.

AML, developed by Theta-Com, utilizes single sideband, amplitude modulated, suppressed-carrier modulation to frequency-multiplex 38 video channels on a 250 MHz CARS band. The VHF band from the cable is shifted directly to the proper microwave frequencies with no need for an interface demodulator in the transmitter. Additionally, the output from the AML receiver is fed directly on to the cable without the need for any signal processing. These conveniences save equipment costs and reduce distortion.

Laser Link, developed by a division of the Chromalloy American Corporation, uses a single carrier frequency to transmit up to a maximum of 18 channels within the 250 MHz CARS band. Laser Link does not use a laser; rather, this LDS uses a form of FM which is derived from pulse width modulation of the carrier by a baseband signal made up of a linear combination of modulated subcarriers (i.e., frequency multiplexed video signals), the combined spectrum of which fits into the 5 to 114 MHz baseband. This composite signal is used to produce a single frequency-modulated 3 GHz carrier.

The economics of using cable versus LDS are discussed in Section IV. The general advantages and disadvantages of cable and LDS are:

1. Cable has great flexibility and growth potential--additional channels can easily be added, especially in both directions (two-way).
2. Cable is a tested performer; LDS is a few years old and has very few years of field operational experience.

3. LDS may be able to eliminate the need for subheadends in an urban cable system by distributing off-the-air signals from a single masterheadend to outlying areas rather than picking up these signals at the subheadend.

4. LDS is currently one-way transmission so that costly conventional FM microwave would have to be used for a few channels in the return path.

5. LDS can "leap" natural barriers such as golf courses, rivers and the like.

Other technical information on LDS, such as reliability and fade margin, can be found in Reference 5.

Distribution for Limited One-Way System

The distribution system for a one-way system would consist of cable and one-way amplifiers for trunk and feeder runs.

Cables for Limited One-Way System

The choice between dual cable distribution (i.e., 24 channels with no set-top converters) and single cable distribution (i.e., 30 channels with converters) depends in part upon the number of strong, local television signals that are present. Because of direct pickup of the off-the-air signal by the TV receiver, certain channel slots on the dual cable system may not be used because the off-the-air signal would interfere with the cable signal. The rationale for using the dual cable distribution system concept for the WCS is discussed in Section IV on the system design.

Cables carrying up to 30 one-way channels must have a bandpass from 54 MHz to 260 MHz for most of the frequency plans being marketed by industry. A usable bandpass from 10 MHz to at least 450 MHz is desirable to allow for future growth in one-way systems as well as for extension of one-way systems to two-way systems. The entire band that is used must be free of discontinuities. The use of seamless aluminum-covered cable having a foamed plastic dielectric is recommended in order to keep cable maintenance to a minimum.

Amplifiers for Limited One-Way System

Solid state trunk amplifiers on the market today are all competitive in terms of noise-figure and output capabilities. In the selection of proper amplifiers for the system, the more important points of comparison are Automatic Gain Control (AGC) and equalization, as well as ease of operation and maintenance.

AGC action and correction for temperature-induced slope[6] changes are problems for which the industry has provided only partial solutions. Early thermal equalizers were only fair in their ability to correct slope changes. Since they were installed only at every third amplifier station, they allowed considerable changes to take place in the system levels at each station. Automatic slope control at every tenth station, coupled with good quality AGC units at every second trunk station, is a good rule of thumb for larger systems with 16 or more amplifiers in cascade. It is preferable to have both slope and AGC controlled by a standard technique that uses one high and one low frequency, called pilot carriers, to continuously monitor the characteristics of the system.

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[6] The term "slope" is used to describe the differing attenuation of the distribution system at different frequencies (Higher frequencies are attenuated more than low frequencies and the relationship is linear when plotted on log paper).

Push-pull amplifiers can be used to reduce distortion of the signals from second harmonics[7] for systems with more than 12 television channels (i.e., a multioctave channel system) but the single fact that they are advertised as push-pull does not mean much. Some manufacturers use push-pull very ineffectively and others cancel second harmonic distortion very effectively without push-pull by properly engineering successive amplifiers to "phase cancel" the second harmonic.

Although a push-pull amplifier costs approximately 10% more than a conventional amplifier,[8] the increased output capability[9] of the push-pull amplifier coupled with the larger number of channels that can be carried, and the flexibility of these channel assignments, has resulted in wider use of push-pull than of other techniques. Current cable system amplifiers are good up to 260-300 MHz.

Another alternative is to use a single octave system.[10] For such a system all second harmonics will fall outside the frequency bands that are used in the distribution system. A single octave system could, therefore, just squeeze 24 channels onto a cable system, while the push-pull readily fits 30 channels on one cable, with no channels above 260 MHz. This 30 channel capacity assumes that two channels will be used in the aircraft navigation band (i.e., 108 MHz to 120 MHz), an assumption that requires further study. As of this writing, the FCC[11] has not decided to implement the advice of the Office of Telecommunications Policy that use of this portion (108 MHz to 120 MHz) of the band be avoided.

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[7] A carrier signal at f_1 passing through an amplifier results in some signal energy at $2f_1$ because of nonlinearity in the amplifier.

[8] Jerrold Electronics Corporation, CATV Systems Division Catalog, 1970.

[9] Lambert, W. H., "Second-Order Distortion in CATV Push-Pull Amplifiers", Proceedings of the IEEE, Vol. I 58, Nov. 7, 1970, p. 1057.

[10] A single octave of frequency starts at f and ends before 2f.

The carriage of twenty-eight to thirty channels has not been tested extensively. There is still great concern in the cable industry whether a cascade of 15 to 25 amplifiers can carry twenty-eight to thirty television signals without excessive degradation from the intermodulation products which result from the interaction of the large number of signals being carried. There are available remedies if these concern prove to be true. Most of the suggested remedies will require extensive testing before a firm recommendation for their use can be made.

One remedy is to pass fewer television signals through the cable; the effects of intermodulation degradation decreases rapidly as fewer signals are carried. For example, some engineers have suggested that an amplifier be limited to 20 to 25 channels. Another remedy is to use more linear amplifiers. At the 1972 National Cable Television Convention, a paper was given on the "Elimination of Cross-Modulation in CATV Amplifiers".[12] This paper and others have promised more linear transistors amplifiers.

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[11] Cable Television Report and Order, FCC, February 3, 1972.

[12] Bell, R. and Clarke, R., "Elimination of Cross-Modulation in CATV Amplifiers," NCTA Convention, May 1972.

Another remedy, pioneered by Switzer,[13] utilized phase locked loops. A phase locked loop can be used to lock the phase of one carrier to another. When the phases are kept locked and the spacing between all carriers is set to a multiple of 6 MHz, most third order distortion products fall on the carrier frequencies with no objectionable beat or intermodulation product since the carriers are in phase. This scheme will be tried in the Toronto cable system. Ken Simons,[14] in a note to the IEEE Frequency Allocations Sub-Committee, has determined which intermodulation products would not fall on the carrier in Switzer's scheme.

Another remedy utilizing phase lock would be to send the television signals with suppressed carrier and to regenerate the carrier at the receiving point with a phased locked loop. This technique would permit the 30 channel composite signal to operate at lower power levels where the amplifier is more linear since much of the composite signal power is concentrated in the thirty carriers. The use of suppressed carrier has great potential for long trunk runs between subheadends, but application to the distribution plant must await the development of less expensive phased locked home television receivers.

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[13] Switzer, I., "Phase Lock Applications In CATV Systems," NCTA Convention, June 1970.

[14] Simons, Ken, "Not All In-Band Beats Are Eliminated By Locking Carrier Spacing To 6 MHz When Carriers Are Not At Multiples Of 6 MHz," IEEE Cable Communications Coordinating Committee, February 15, 1972.

The system recommended for the Washington Cable System is a 28 to 30 channel system. MITRE recommends that prior to procuring the equipment for the WCS that the cable system operator should determine which of the techniques described above have been tested and proven out and that the then-available field experience with 30 channel systems be thoroughly investigated.

Subscriber Terminals for Limited One-Way System

By 1971, set-top converters had been much improved over the earlier models. Conversion-oscillator instability, oscillator feed-through to the receiver, and other faults have been resolved through greatly improved designs. Cable system operators in New York City, with more than 70,000 converters in use, say they are getting satisfactory operation from their converters.[15] They are using the Hamlin MCC 700 and MCC 1000 units and the Oak Electro-Netics Gamut 26. The Gamut 26 uses a three-stage IF at 330 MHz. The first local oscillator (tunable) beats with one of the signal frequencies on the cable to produce the IF. A second local oscillator beats with the IF to produce an output at the frequency of a standard television channel which is not in use by broadcast TV channels.

MITRE concludes[16] that most of the troubles plaguing converter users the last few years have been brought under control. This has been accomplished by retaining the principle of a double superheterodyne converter, locating the intermediate frequency amplifiers in the ultra high frequency (UHF) band. Operation of oscillators and mixers at these high frequencies produces beats just as they had at lower frequencies, but not both sum and difference frequencies were high enough to be out of the CATV and standard television channel bands.

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[15] "Big City Cable TV - A Tortuous Labyrinth," BM/E - Cable Management Engineering, April, 1971.

[16] Skinner, F. L., "CATV Set-Top Converters," The MITRE Corporation, M71-69, Washington, D.C., November 1971.

When most types of set-top converters are used the tuner of the TV set is not utilized, so that the converter function may be incorporated in a special TV receiver designed for cable television. The NCTA has asked the FCC to establish standards for a 20, 40, and 60 channel TV set that uses detent or electronic tuning. This set would have a 75 ohm input for cable signals. Magnavox introduced a prototype of their "101" receiver at the 1971 NCTA Convention.[17] This set has a built-in converter and can be tuned to all VHF, UHF, and cable signals.

SYSTEMS FOR FULL ONE-WAY SERVICES

Some types of one-way services require of a frame-stopper terminal, an unscrambler or privately addressed channel at the home terminal. This section discusses the terminal, headend and distribution requirement for such "Full" One-Way Services.

Terminals for Full One-Way System -- Frame-Stoppers

When individual frames of the standard television signal are encoded with digital addresses, they can be sent to selected receivers by using decoder units in these receivers designed to look for a particular digital address. Receivers equipped with decoder units will accept only those signals that are coded for their particular "address" (i.e., the code for which their decoder is set) even though other frames are also being transmitted on the same channel. Thus, in order for a TV picture to remain on the receiver screen (when new frames for that receiver are not being sent continuously at a rate of 60 frames per second), the TV receiver requires a "refresh" device to replay the frame the viewer wants to see on his receiver screen at the conventional 60 times a second. This process is known as "frame-grabbing," "frame-freezing," "frame-snatching," and "frame-stopping." It is used, for instance, in some airports to update departure/arrival schedule TV displays for different airlines, all using the same channel, but each airline with its own display locations.

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[17] TV Communications, August 1971.

The terminal described above, is estimated at from $60 to $800. A single frame, alphanumeric storage and refresh device using integrated circuit technology is projected at $60 for large quantities. The 1972 price of a video tape recorder (VTR) frame-stopper is approximately $800. A frame-stopping terminal using a VTR could also be used to record movies or programs sent during the night to individual TV sets. It is expected that this capability will be part of the video tape recorder/video cassette "revolution", if it materializes and that the wide-spread use of this type of additional one-way capability will be a function of what types of services requiring frame-stopping are offered. MITRE is presently experimenting with a demonstration of this type of Full One-Way Service in the Reston new community near Washington, D.C.[18]

Several companies are building other types of refresh devices. For instance, System Resources Corporation, Plainview, New York, has demonstrated a video disc that could be applied in lieu of the video tape or cassette recorder. The VIDIMEM^{TM} uses a circular disc of mylar tape that is driven by a motor synchronized with the TV frame rate. Centrifugal force stiffens the mylar disc. A magnetic head is used, and the current model will capture one frame. A two track model that will grab two frames has been demonstrated and plans for a four frame freezer are being explored. For very large quantities, the black and white VIDIMEM^{TM} might cost as little as $150, with color capability costing an additional $30 to $40.

Hughes Aircraft Corporation has a frame catcher built around a storage tube that can be purchased today in large quantities for about $500 each. The Hughes frame catcher uses a Hughes Type H-1268B scan converter tube of the type that may eventually be available at a manufacturing cost of less than $20 for the tube. Sylvania is currently developing a storage-tube frame stopping device, also. MITRE estimates that the capital cost of a storage-tube frame catcher including associated electronics will eventually be approximately $100 in quantities of 10,000.

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[18] Volk, J. L., "The Reston, Virginia, Test of The MITRE Corporation's Interactive Television System," The MITRE Corporation, MTP-352, Washington, D.C., May 1971.

Headend for Full One-Way System

Some of the Full One-Way Services described in Section III will require the types of terminals discussed above. For these services the headend must have all the equipment described for the conventional one-way services plus a computer that stores and selects frames and provides an addressing function for the frame-stopper and/or an encoder or scrambler. In this case, the computer could also provide the scrambler functions at the headend. Cost estimates for the 1974 to 1976 time period for such a basic computer complex are around $150K to supply each of about 1000 subscribers with an hour a day of computer generated information. For a full scale implementation of frame-stoppers in the WCS with about 100 computers, the initial software cost is estimated at $1M to $2M.

For the frame-stopper, the computer would address individual television frames for reception at all of the home terminals. As indicated previously all frames would be sent to all the subscriber terminals on a time-multiplexed basis. The subscriber, by means of a selector dial, and using a TV reference guide, chooses the frame that he wishes to view. The computer must be programmed to select the appropriate data or program materials from a mass memory.

Distribution for Full One-Way System

For these Full One-Way Services, no hardware over and above that required for conventional one-way service would be required for the distribution system. Moreover, each channel could carry many sub-channels of information (e.g., 600 different frames each 10 seconds) all of which can be received by as many viewers as wished to select them.

Facsimile - A Special Note

One popular concept for Full One-Way Service is the transmission of newspaper materials to subscribers via facsimile. It has been noted in Section III that there is a growing interest in a practical means of printing news in homes and offices to alleviate some of the transportation and house-to-house delivery problems. A facsimile system would provide, with minimum delay, a lasting record of significant events as they occur.[19]

Toshiba (Japan) has developed a system which transmits a 12-1/2" by 18" tabloid size newspaper page over a FM radio channel with a bandwidth of 200 KHz, and uses a multi-stylus device for reception on facsimile paper. The system can reproduce both sides of a newspaper page in five minutes with a resolution of 8 lines per millimeter (i.e., 200 lines per inch). Toshiba estimates[20] an initial cost of $280 for the system in consumer volumes. The initial cost of a single-sided system would run about $140. A major problem of this system has been the high cost of special electron tubes, necessary for the "multi-stylus" device.

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[19] Tewlow, Jules, "A Report from Japan", Bulletin 1036, ANPA Research Institute, New York City, N.Y., December 28, 1970.

[20] Thompson, J. P., "The Outlook for Broadband Telecommunications," 26th National Electronics Conference, 9 December 1970.

Home facsimile is not yet suitable as a substitute for newspaper delivery but it can be expected to soon provide a convenient way to transmit documents between homes and businesses. Facsimile technology presently is such that a three minute-per-page system would cost about $100 per month for the send-receive station plus $1 per page for telephone line charges. High-speed systems (such as XEROX LDX) cost about $1200 per month for send-receive stations with lines charges of about $1000 per month for service within Washington. Transmission speed is 10 seconds per page.

The development of universal high-speed facsimile systems is being constrained by the high cost of transmission and the lack of a nationwide, switched, broadband network. Both high-speed and low-speed facsimiles are entangled in the legal issues of copyright and security. Most of the present low-speed facsimile machines are noisy, smelly, unreliable, require special paper and will not copy from books. A cable system such as the WCS can offer the broadband channels needed for the high-speed facsimile services. Channels that are 12 or 18 MHz wide could be made available.

Examples of Terminal Hardware for One-Way Systems

Figures B-2 to B-6 show the range of equipments that could be added to the subscriber terminal to provide for both limited and full one-way services of the types discussed above, except facsimile. Figure B-6 shows a full one-way terminal, similar to those being demonstrated by MITRE at Reston, Virginia.[21]

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[21] Volk, J. L., See Reference 15.

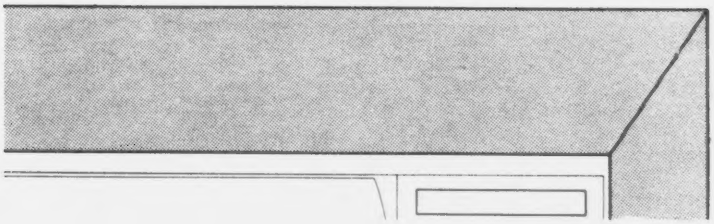

FIGURE B-2
REGULAR TV

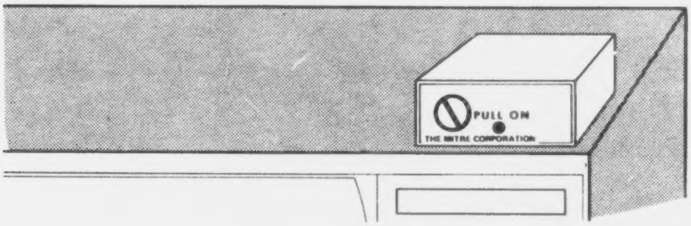

FIGURE B-3
TV PLUS CONVERTER

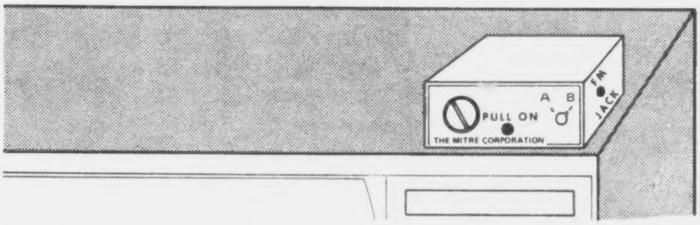

FIGURE B-4
DUAL CABLE

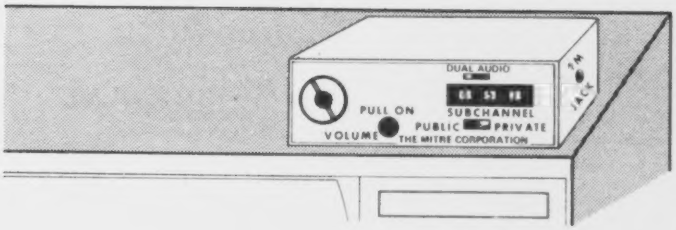

FIGURE B-5
PRIVATELY ADDRESSED CHANNELS (FOR DOCTORS, SPECIAL PROGRAMS, ETC.)

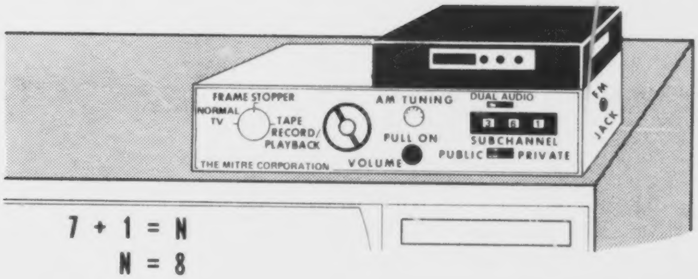

FIGURE B-6
FULL ONE-WAY SERVICES

Future requirements for high resolution at terminals may require channels with bandwidth greater than 6 MHz. Cable systems should allow for future expansion into these services.

SYSTEM FOR LIMITED TWO-WAY SERVICES

Limited Two-Way Service requirements include a short response message (generally less than 100 bits of information) from the subscriber back to the headend or computer center. This message can be a coded request, status report, or signaling message.

Headend for Subscriber Response Services

The headend equipment for limited two-way services would include a computer and interface equipment and internal headend communications as shown in Figure B-7 as well as the conventional cable headend and studios.

The headend computer controls the time of response of each subscriber terminal. It retains in its memory the address of each subscriber and will electronically query each subscriber at periodic intervals. The content of the information received from each subscriber is examined, decoded, organized, etc., by the computer or passed to appropriate locations for action, e.g., burglar and fire alarm information.

If the terminals were to report to the headend computer at will, rather than in response to computer queries (i.e., polling) the

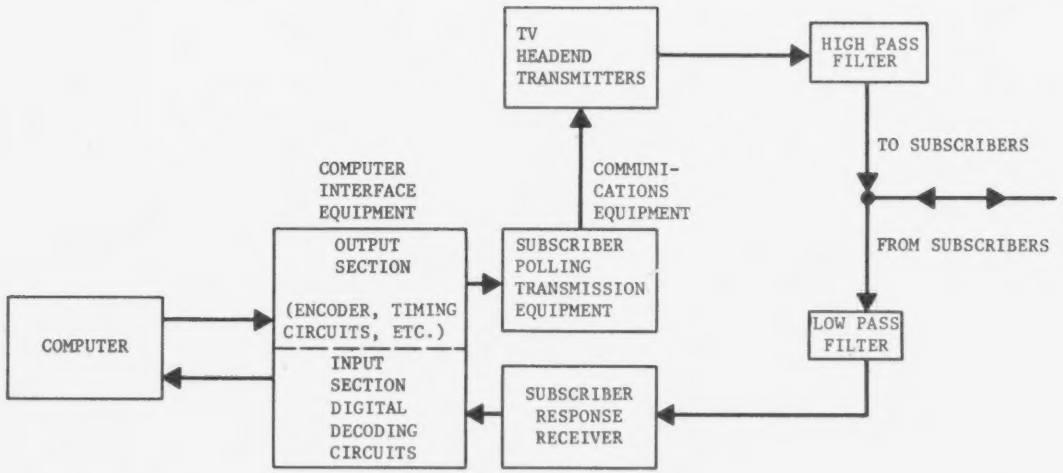
COMPUTER
COMPUTER INTERFACE EQUIPMENT
OUTPUT SECTION
(ENCODER, TIMING CIRCUITS, ETC.)
INPUT SECTION DIGITAL DECODING CIRCUITS
TV HEADEND TRANSMITTERS
COMMUNI-CATIONS EQUIPMENT
SUBSCRIBER POLLING TRANSMISSION EQUIPMENT
SUBSCRIBER RESPONSE RECEIVER
HIGH PASS FILTER
TO SUBSCRIBERS
FROM SUBSCRIBERS
LOW PASS FILTER

FIGURE B-7
BLOCK DIAGRAM–SUBSCRIBER RESPONSE SYSTEM, HEAD END

messages would become garbled because of overlapping signals.[22] Even when using computer query procedures, the signal propagation time to the most distant subscriber must be taken into account to avoid the garbling of messages. Since the computer will interrogate each terminal every few seconds the time delays necessary to account for signal propagation are not noticeable to the subscriber.

The computer interface equipment will provide any necessary conversion of the computer input/output data into a form compatible with the distribution system equipment and will provide the timing necessary for proper system operation. It will also provide the buffering necessary between the many subscribers and the computer and convert the parallel data from the computer to serial data for transmission to the subscribers.

The computer equipment and software would cost about $100,000[23] for a simple subscriber response system. As described later in the section on Subscriber Terminals for Subscriber Response Services, either the time for the signal to propagate from the computer to the subscriber and back or the need to respond to a subscriber in a reasonable length of time will limit the number of subscribers that can be handled by each computer to a total of about 50,000.

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[22] Ward, J. E., "Present and Probable CATV/Broadband-Communication Technology," Prepared for Sloan Commission On Cable Communications, June 7, 1971 (Revised January 5, 1972), ESL-R-449, MIT, Cambridge, Massachusetts, p.4-5. This paper considers alternatives to avoid overlapping signals.

[23] Baer, W. S., "Interactive Television, Prospects for Two-Way Services On Cable," RAND R-888-MF, November 1971.

Distribution for Subscriber Response Services

The distribution plant will require additional capability for two-way operation. Several means of obtaining two-way operation have been considered. For example; two-way transmission on a single cable, use of a second or third cable for a dedicated return link, telephone lines, wire pairs, or a switched distribution system (i.e., Rediffusion or Discade) [24] are all potential means of obtaining two-way operation.

The forward direction or "downstream" signals are carried in the VHF band and include the usual video signals and the computer signals to the subscribers. Most major cable electronics manufacturers are supplying two-way cable transmission equipment that uses frequency multiplexing to supply the reverse or "upstream" direction of transmission. These response signals from the subscriber terminals can be placed in the sub-VHF band below 50 MHz with a guard band to allow for the necessary filtering to avoid interaction between the signals flowing in opposite direction on the cable. One of the advantages of utilizing the sub-VHF band rather than the high-band region for return signals is reduced cable attenuation. Cable attenuation for frequencies in the sub-VHF is approximately one third of the cable attenuation at the upper extreme of the VHF band with the result that fewer cable amplifiers are required for the return signals. Two schemes for channel assignments are shown in Figure B-8 which was presented by Jerrold Electronics Corporation at the 1971 NCTA Convention.

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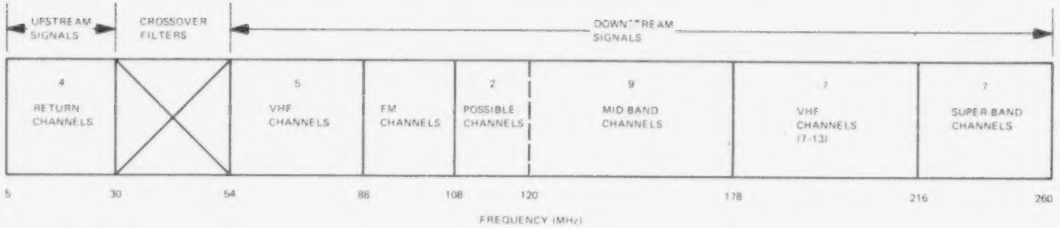
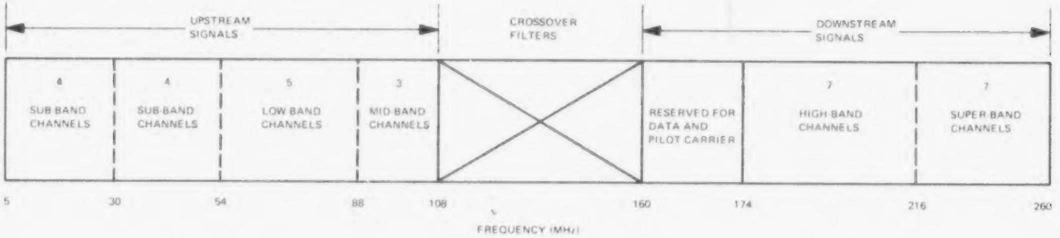
[24] Ward, J. E., See Reference 22.



(A) USING "LOW SPLIT" FILTERS



(B) USING "MID-SPLIT" FILTERS

SOURCE: JERROLD ELECTRONICS CORP.

FIGURE B-8
FREQUENCY MULTIPLEXING SCHEMES FOR TWO-WAY TRANSMISSION

The trade literature on cable generally implies that any of the four sub-band reverse channels could be used for video return. In fact, discussions with equipment manufacturers have pointed up the fact that the upper 6 to 9 MHz of the sub-band will probably not be suitable for upstream color video transmission because of phase distortion caused by the diplexor filter (see Figure B-9) which separates the two directions of transmission. The problem is aggrevated by the fact that the downstream Channel 2 must not be affected by the diplexor filter, so that the phase distortion that cannot be removed must fall in the upstream channels. Recent discussions with a major system operator indicate that the 50 to 260 MHz band is not unaffected by the filter and that early tests have indicated a need for better filters.

Further, the reverse channel will be very noisy unless the cable system is structered (as in the WCS) as a series of hubs which feed several trunks. The hub design reduces the number of reverse channel amplifiers that feed back to the headend. Each subscriber television set and each reverse amplifier of the tree, contributes to the noise on the reverse channel. (In the forward direction, only the amplifiers in the path to the subscriber contribute noise.[25]) Another requirement is that high quality drop cable and shielded terminations be installed in each home to reduce the coherent interference entering the system from shortwave transmissions operating in the sub-band such as the Voice of America and ham radio operations.

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[25] Barnhart, A. W., "Two-Way CATV Systems Performance", IEEE Transactions On Broadcasting, Vol. BC-18, No. 1, March 1972.

ADAPTED FROM:
A. W. BARNHART, JERROLD ELECT. CO.
JULY, 1971 NCTA CONVENTION
WASHINGTON, D.C.

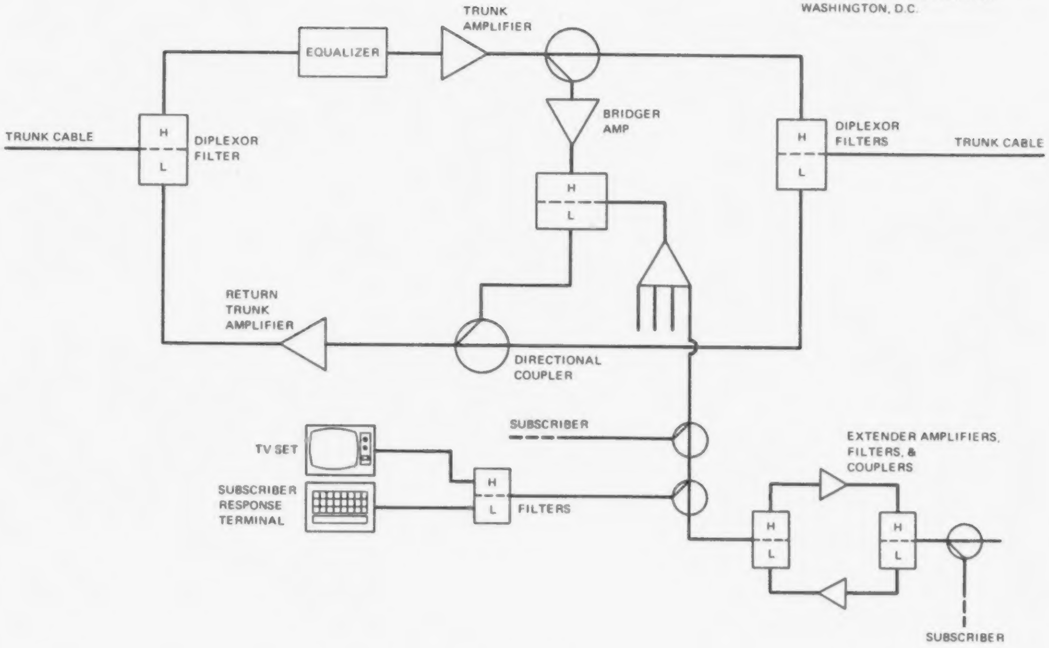

FIGURE B-9
ILLUSTRATIVE DISTRIBUTION LAYOUT

Terminals for Subscriber Response Services

A possible subscriber response terminal, shown in block diagram form in Figure B-10 will include for one-way operation a set-top converter with provision for an A/B switch and, of course, the ubiquitous television set. The converter may actually contain the A/B switch; detailed economic considerations will define this aspect. The converter will permit the viewing of all 30 channels to be carried on the first telecasting cable of the WCS. Where required, as discussed in Section III a dual audio reception capability can be provided within the subscriber terminal equipment to permit the selection of either a Spanish or an English sound track. The foreign language sound track would be carried over an extra subcarrier as FM multiplex is now transmitted.[26]

For the subscriber response services the terminal will be provided with the above-mentioned terminal equipment plus a polling receiver, a modulator-transmitter, a serial-to-parallel converter, parallel-to-serial converter, and various gating and control circuits, all of which can be packaged in a small 3" by 10" by 6" box.

There are several subscriber terminals under development at the time of this writing. At the 1971 NCTA Convention in Washington, D.C., Hughes Aircraft Company, CAS Manufacturing Company, and Scientific-Atlanta, Incorporated, presented the Subscriber Response System, TOCOM

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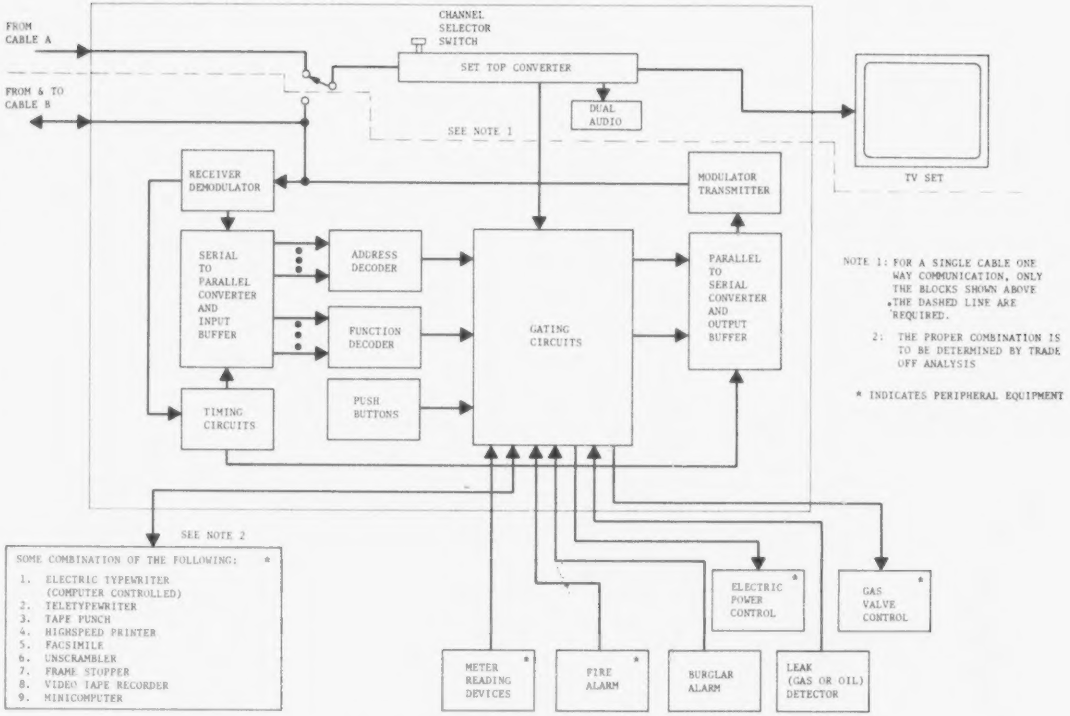
[26] Numaguchi, Y, et. al., "Simultaneous Transmission of Two Television Sound Channels," NHK Laboratories Note No. 132, NHK Laboratories, Tokyo, Japan, February 1970.



SOME COMBINATION OF THE FOLLOWING: *

1. ELECTRIC TYPEWRITER (COMPUTER CONTROLLED)
2. TELETYPEWRITER
3. TAPE PUNCH
4. HIGHSPEED PRINTER
5. FACSIMILE
6. UNSCRAMBLER
7. FRAME STOPPER
8. VIDEO TAPE RECORDER
9. MINICOMPUTER

NOTE 1: FOR A SINGLE CABLE ONE WAY COMMUNICATION, ONLY THE BLOCKS SHOWN ABOVE THE DASHED LINE ARE REQUIRED.

2: THE PROPER COMBINATION IS TO BE DETERMINED BY TRADE OFF ANALYSIS

* INDICATES PERIPHERAL EQUIPMENT

FIGURE B-10
SUBSCRIBER TERMINAL BLOCK DIAGRAM

and Security Alert, respectively. In February 1972, the Hughes equipment was transferred to its wholly owned subsidiary, Theta-Com for final product design, manufacture, and marketing. These two-way systems envision subscriber terminals costing anywhere from $100-$150 (CAS and Scientific-Atlanta) to $250 (Hughes). Thirty Theta-Com prototype terminals will be used as part of tests at El Segundo, Calif., in the Spring of 1972. Theta-Com plans to enlarge the test to 1000 terminals in late Fall 1972.

The subscriber terminals that were compared as part of a study and survey[27] of subscriber terminals are summarized in Table B-3. This table includes devices discussed next under "Automatic Sensor Interrogation Services". Table B-3 lists the primary characteristics of each terminal and associated system. The services provided by these systems are listed in Table B-4, which is also taken from Reference 27. Another useful study of home terminals is described in Reference 23.

The other Limited Two-Way Services discussed in Section III, can be added at a further increase in terminal costs. The system design would provide for the inclusion of two or more "function codes" in the interrogation query from the computer at the subheadends. The function-code would determine which of various possible responses would be transmitted by the subscriber terminal. For example, one function code might request a report on what channel the viewer is watching; another might

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[27] Nickel, W. S., "Cable System, 2-Way Polling/Control Services," MITRE WP-7575, August 26, 1971.

TABLE B-3
SUMMARY OF TWO-WAY EQUIPMENT

SYSTEM NAME	MANUFACTURER	SYSTEM CHARACTERISTICS							
		NO. OF TV CHANNELS	DIGITAL DATA TRANSMISSION					TYPE OF SUBSCRIBER TERMINAL	COST
			DOWNSTREAM FREQUENCY, MHz	BAND WIDTH, MHz	UPSTREAM FREQUENCY, MHz	BAND WIDTH, MHz	DATA RATE		
Subscriber Response System	Theta-Com Los Angeles, California (Hughes Aircraft Company)	26	110	4	23	4	1 Mb/s	4 Button Console, Modem 17 Button Console, Printer, Modem	$200 [illegible]
Video - [illegible]	Video Information Systems New York, New York	26	110	4	12	4	1 Mb/s	Converter with 7 Buttons added	$250
Channel Monitor System	Electronic Industrial Eng. North Hollywood, Calif.	34	115 (approx.)	0.2	10-15	2	1 Mb/s	4 Button Control, A-B Switch, Modem	$100
Interaction Television	Vicom Mfg. Company Ann Arbor, Michigan	23	112, 114	4	8	4	1 Mb/s	12 Button Console, Modem	$250
TOCOM	CAS Mfg. Company Irving, Texas	26	50	0.2	6-10	10		Converter with 3 Buttons added	$100
	Subscription TV South Pasadena, California	EQUIPMENT		NOT			AVAILABLE		
Security Alert System	Scientific-Atlanta Atlanta, Georgia	None	112.5	2.8	0.25	0.05	160 Kb/s[1] 5 Kb/s[2]	Alarm Interface	$100
Holo-Com	Holmes Communication Corp. New York, New York	None	5-25	--	5-25			Alarm Interface	$200
Versacom	Advanced Research Corp. Atlanta, Georgia	None	0.3-0.5		0.3-0.5		2 Kb/s	Alarm Interface	
Status Monitor	Cascade Electronics, Ltd. Port Moody, B.C.	--	--	--	5-5.64	0.01	N.A	None (Trunk amplifier monitoring station)	[illegible]
Arvetel	Badger Meter Mfg. Company Milwaukee, Wisconsin	--	--	Telephone		lines		Meter Reader	$ 10

1. Downstream
2. Upstream

TABLE B-4
SUMMARY AND COMPARISON OF SERVICES

SYSTEM NAME	MANUFACTURER	Cost	SERVICES PROVIDED No. of TV Channels	Reporting of Selected Channel	No. of Buttons (Keyboard) for Opinion Polling, etc.	Pay TV Facilities	Restricted Channels	Purchase-at-home	Burglar Alarm	Fire Alarm	Emergency Alarm	Meter Reading	Printer (A - Hard Copy)	Video Signal from Home	Audio Signal from Home	Character Display on TV Set	Control of Home Services or Home	Monitoring of Cable Amplifier Output
Subscriber Response System	Theta-Com Los Angeles, California (Hughes Aircraft Company)	$200 $230	26	X	4 17	X X	X X	 X	o o	o o		o o	 X				o o	
Video + 12	Video Information Systems New York, New York	$250	26	X	5	X		X										
Channel Monitor System	Electronic Industrial Engr., Inc. North Hollywood, California	$100	24	X	3	X			o	o				o				
Interaction Television	Vicom Mfg. Company Ann Arbor, Michigan	$280	25	X	12		X		o	o	o	o	o	o	o	X	o	
TOCOM	CAS Mfg. Company Irving, Texas	$100	26	X	3	X			o	o	o	o						
	Subscription South Pasadena, California			X		X		X	o	*	o	o	*					
Security Alert System	Scientific-Atlanta Atlanta, Georgia	$100	None		o				o	o	X							
Holm-Com	Holmes Communications Corp. New York, New York	$200	None		o				*	*	*							
Versacom	Advanced Research Corporation Atlanta, Georgia		None															
Status Monitor	Cascade Electronics, Ltd. Port Moody, B. C.	$175	--		o													X
Armeter	Badger Meter Mfg. Company Milwaukee, Wisconsin	$ 10	--		o						X							

X Equipment provides the listed service
* Peripheral Equipment Supplied
o Connection only provided

request a reading from one of the subscriber utility meters or the status of his burglar alarm surveillance devices. A third function code could be used to turn off the subscriber's electric hot-water heater or other electric appliances, if he subscribes to such a service.

Automatic Sensor Interrogation Services

The utility services described in Section III, such as meter readings and selective power load control, will require additional hardware at the subscriber location and the headend. The headend will require use of a computer, of the type described earlier, to direct the meter reading and power load control and to record the results.

Power load control will require the installation of on/off switches at the subscriber locations to turn selected devices on or off. MITRE believes that the devices to be installed in the home can be built for less than $35, but the cost of installation might inhibit the general acceptability of the idea in existing homes. On the other hand, for new residential construction, especially in new communities, and in commercial establishments, the devices show great promise.

Meter reading will also require installation of low cost hardware. A potential candidate for this task is being produced on a trial basis by the Badger Meter Manufacturing Company of Milwaukee, Wisconsin (see Table B-3). Current versions of this meter are currently being designed for telephone interrogation of meters but could be easily adapted to cable systems. The cable system can produce faster interrogation of meters, hence more meters can be read per unit time than can be telephone lines and has the added advantage of keeping the telephone lines and plant equipment free for telephone calls. A low-cost meter reading system such as this is described in a recent MITRE report.[28]

The Bell System has been running feasibility tests of meter reading with various utilities and manufacturers of meter reading equipment for a number of years. Illinois Bell Telephone and five local utilities have just completed a test in the Chicago suburb of Summit which attempted to determine communication, maintenance and installation costs. A report on the costs involved in this test is to be written by the Utilities Telecommunications Council. Bell does not expect to announce its decision on a tariff for meter reading until mid-year 1972.[29]

In summary, the future of automated meter reading depends very much upon the communication costs and the initial capital cost of the meter reading equipment versus the labor costs. As discussed earlier, the home subscriber terminal could be used as part of a low cost communications method of reading meters via cable. Reference 28 describes a low cost meter reading device that would utilize the wide cable bandwidth and attendant high data capacity. On the other hand, the manual meter readers are "becoming increasingly difficult to recruit; often they must travel in pairs for safety and a growing number of fearful urbanites do not allow them to enter homes."[30] Further, "remote reading will enable utilities to locate paper failures instantly ..., be easier to make load studies and discontinue service more quickly when families move."[31]

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[28] Eldridge, F. R., "System for Automatic Reading of Utility Meters," The MITRE Corporation, M72-7, Washington, D.C., September 1, 1971.

[29] "A black box to replace the meter reader," Business Week, February 1972.

Implications of Terminals Upon Distribution for Subscriber Response Services

The initial systems that have generally been proposed would provide for data transmission both upstream and downstream in burst of data at a rate of approximately one megabit per/second. The data processing subsystems would allow each subscriber terminal to input approximately 100 bits of data for each system query. One manufacturer estimates that 2 to 3 megabits per/second can be sent in a 6 MHz television channel if appropriate equipment is used.

Equipment manufacturers have indicated response times varying from 160 microseconds to 1 millisecond for each subscriber. This system response time includes the signal propagation time. The propagation delay for the foamed polyethylene dielectric coaxial cable that has been typically used in cable systems is on the order of 7 microseconds per mile with an additional delay of one microsecond per cable amplifier for a maximum of 3 amplifiers per mile. Thus a total delay of 10 microseconds for each mile of installed cable and amplifiers must be planned for. An industry rule-of-thumb is 8 microseconds of delay per mile of cable with amplifiers (in each direction).

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[30] Business Week, quoting an official of the Utilities Telecommunication's Council, see Reference 26.

[31] Business Week, quoting an official of Metrolab, a Cubic Corporation subsidiary, see Reference 26.

There are inexpensive communications schemes for obtaining two-way digital data transfer between any two subscribers on cable television systems where the polling computer described earlier is used to collect 'store and forward' messages.[32] The home terminal for this scheme would cost approximately $10 more than the other cable home terminals mentioned earlier. No additional cost would be required in the distribution plant while the additional costs at the headend involve some additional storage capacity - a cost spread over all subscribers.

Headend for Electronic Information-Handling

The computer capability used in Electronic Information-Handling would be larger than that of the Subscriber Response System. The required computer capability was described under the subsection, Headend For Full One-Way Systems.

Distribution for Electronic Information-Handling

The distribution pattern for Electronic Information-Handling is the same as that used in the Subscriber Response System.

Terminals For Electronic Information-Handling

The frame-stopper and keyboard described earlier under the subsection, Terminals For Full One-Way Systems, are needed for a number of

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[32] O'Neill, J. J., "Two-Way Digital Communication Between Subscribers On A Cable Television Network," WP-8578, December 22, 1971.

Electronic Information-Handling Services. In response to subscriber inquiries, individual frames of program materials and data contained in computer storage are transmitted, addressed to the subscriber's terminal.[33,34] This type of frame-stopping capability together with a very flexible subscriber input terminal can be used to provide computer aided instruction (CAI) and a number of other types of two way electronic information-handling services discussed in Section III into the home.

Terminals - Private Modes and Premium TV

In general, it is expected that private cable services[35] such as mail delivery, bank account information, credit checks, stock portfolio information and access to personal files, will be provided on two-way Electronic Information-Handling Systems using time sharing techniques to enable available channel space to be used most effectively.

Private Transmissions using two-way time-shared channels will, in most cases, be originated from private sources, stored and retrieval from private data banks, and addressed to unique terminals in the cable system. In contrast, Premium TV programs, such as first-run movies,

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[33] Volk, J. L., "The Reston, Virginia, Test of The MITRE Corporation's Interactive Television System," The MITRE Corporation, MTP-352, Washington, D.C., May 1971.

[34] Mason, W. F., and Polk, S., "Revolution In Home Communication - New Techniques For Using Computers With Cable Television," The MITRE Corporation, M72-38, Washington, D.C., March 1972.

[35] Eldridge, F. R., "Privacy for Cable Services," The MITRE Corporation, M72-59, Washington, D.C., May 1972.

special national sports events, and various types of special cultural events such as symphony recitals, opera, theatre plays, etc., will, generally be cablecast on exclusive channels to large audiences. Special programs for doctors, lawyers or other groups with special interests could be provided in the Premium TV mode.

At present, a number of Premium TV Systems are being developed for use on cable.[36] Many of these are, currently, aimed primarily at hotel and motel applications. Some of these types of systems are summarized in Table B-5. Most of the currently available Premium TV systems would use one-way cable. Many of the systems transmit signals that are scrambled by removal of the sync pulses, or the signals are switched-on at the viewing terminal by a central control-station. None of these currently available Premium TV Systems would be suitable for sending large numbers of specific terminals in a large city.

One class of systems that should be considered as having the potential for providing privacy of information transmitted via cable, are switching systems, such as those produced by Rediffusion[37] (i.e., The Dial-a-Program System) and Ameco[38] (i.e., the DISCADE System). However, it should be noted that the switching in these systems, as currently designed, is controlled by the viewer rather than the sender.

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[36] "Premium TV to Get Real Test in 1972," Cable Management Engineering, February 1972.

[37] Gargine, E. J., "Dial-A-Programme Communication Television," The Royal Television Society Journal, Vol. 13, No. 5, September/October 1970.

[38] Hickman, J. E., and Kleykamp, G. C., "Multicable Solution To Communications Systems Problems," IEEE Convention, March 1971.

TABLE B-5
SUMMARY OF PREMIUM TV SYSTEM DEVELOPMENTS

NAME OF SYSTEM	TYPE OF CABLE SYSTEM REQUIRED	METHOD OF EXCLUDING NON-PAYING VIEWERS	METHOD OF ACCOUNTING FOR SERVICE CHARGES	ESTIMATED INCREMENTAL CAPITAL COSTS
BTVision	One-Way	Video sync pulse and audio signal sent on separate channels, and recombined with video signal at receiver	Identification code for each program recorded on audio cassette and returned, periodically, by mail	$100 per Terminal
EnDeCODE	One-Way	Similar to BTVision	Fixed rate for service	$40 per Terminal
Computer Television	Two-Way	Viewer transmits program requests to central control station via cable. Central control remotely sets varactor tuners in subscriber terminals	Central control records programs requested	$600 per Terminal
K'Son	One-Way	Viewer telephones requests to central control station. Central control remotely sets program selector units to desired channel	Central control records programs requested	$100 per Terminal
Optical Systems	One-Way	Encoded signals sent from headend which are decoded at receiver by use of decoder cards or plug-in decoder cartridges	Viewer buys decoder cards or plug-in decoder cartridges for series of programs	$35 per Terminal
Phonevision and Theatre VisioN	One-Way	Encoded signals sent from headend which are decoded at receiver by subscriber ticket and decoder control unit	Viewer buys decoder tickets for individual programs	Not specified

Each viewer, therefore, would have access to all messages on every time-shared private channel to which he had access through the local switching center. A possible means of overcoming this problem would be to supply these switching systems with address gating such as is being done for the MITRE TICCIT System.[39]

In the TICCIT System each conventional TV field carries an address, in the form of a series of bits inserted before the vertical retrace period that precedes the field. If the address of a field matches that of an address decoder that is inserted in the system, it passes through a corresponding gating circuit and is received by the terminal to which it is addressed. A unique address is provided for each terminal. Such a configuration is shown schematically in Figure B-11.

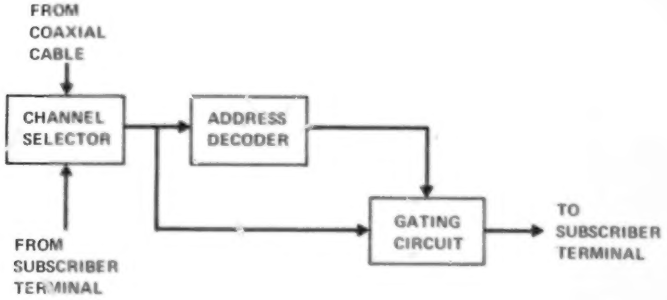

FIGURE B-11
SYSTEM FOR CHANNEL SELECTION AND ADDRESS GATING

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[39] Stetten, K., "TICCIT: A Delivery System Designed for Mass Utilization," The MITRE Corporation, M71-56, Washington, D.C., October 1971.

One problem in regard to the privacy of the address-gating as presently operated on the MITRE TICCIT System in Reston is that all messages carried by each channel are sent to each home and could be taped and read by every user of the system. Since an important objective, here, is to maintain security for all private messages on these channels, each subscriber's address decoder and gating circuit should be located outside of his home and preferably in a local distribution center such as the strand-mounted Area Distribution Center, in the case of the DISCADE System, or in the Program Exchange Center, in the case of the Dial-a-Program System. This will prevent each subscriber from having access in his home to everybody's private messages on the time-shared private channel to which he has switched. By locating his address decoder and gating circuit outside of his home, only those private messages addressed to him will reach his home.

There are many possible variations on this type of privacy system. For instance, an alternative would be to eliminate the use of a local distribution center and, instead, to locate the channel selector, address decoder and gating circuits, shown in Figure B-11, in an external unit at the input end of the subscriber's dropline, either on a utility pole or in an underground conduit, and to provide for remote tuning of the channel selector from the subscriber's terminal.

In still another version, a Premium TV mode could be added to the system. Each Premium TV field would carry a "price-per-field" code as well as a Premium TV address code. Each subscriber's external unit, in addition to the subscriber's unique address decoder, would contain a Premium TV channel address decoder which would be the same for all Premium TV subscribers. When the subscriber tunes into a Premium TV channel, these fields would pass through the Premium TV gating circuit as shown in Figure B-12, and the count of the "price-per-field" code would be registered in the Subscriber-Response Unit, the details of which are shown in Figure B-13. The Premium TV field would then pass to the home terminal unit. The price information would be sent to a central processing unit for billing purposes.

Likewise a private mode field, bearing the subscriber's address, would be passed to the subscriber's terminal unit and through a refresh unit if field-stopping is required.

Open channel signals would be passed directly to the home terminal unit from the remote channel selector and converter.

A keyboard would be supplied in the home terminal unit for generation of upstream signals through the Subscriber-Response Unit for functions such as opinion polling, catalogue shopping and reservation services. This unit could also be used for meter reading, selective power control; maintenance checking, burglar alarms, fire alarms and other sensor interrogation services, as discussed previously.

Studies have indicated a comprehensive two-way terminal of the type described above, in production quantities, would cost anywhere from $327 to $627 without privacy or Premium TV modes. It is estimated that the cost of extra components needed for these modes and packaging and weatherproofing of the components that would be located in the

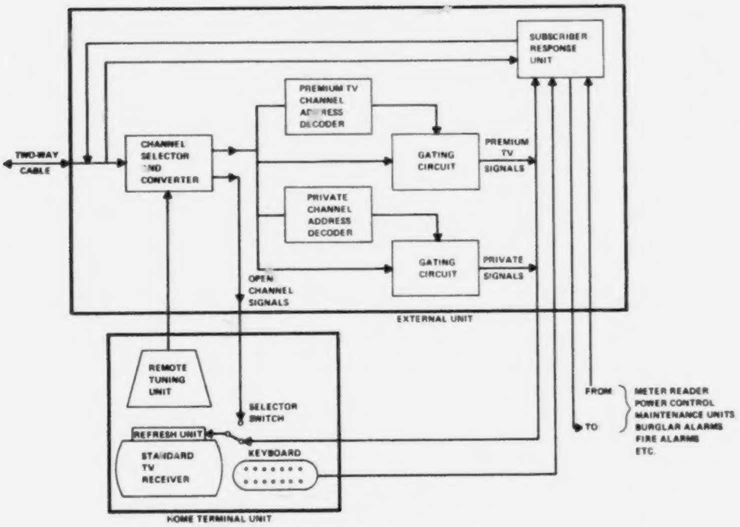

FIGURE B-12
UNIVERSAL TERMINAL

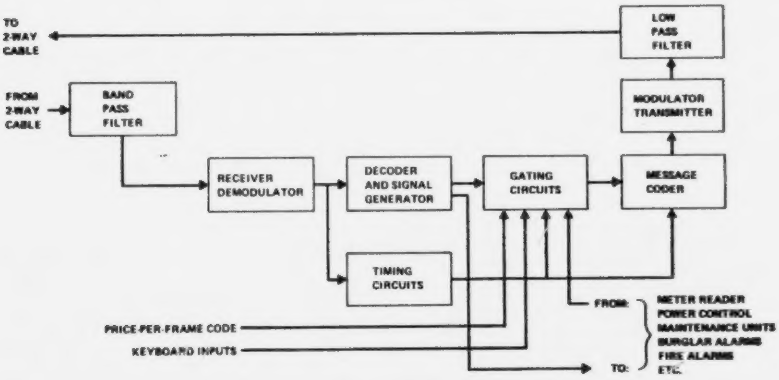

FIGURE B-13
DETAILS OF SUBSCRIBER-RESPONSE UNIT

external unit, would add about 10% to these costs.

In summary, it appears that an attractive and relatively inexpensive means of providing both private communications and Premium TV services to homes, and other potential subscribers, would be to include an external unit, located either in a local distribution center or mounted on a pole or in an underground conduit at the input to the subscriber's dropline. This external unit would contain a means for remote channel-selection by the subscriber, as well as address-gating and subscriber-response units.

SYSTEMS FOR FULL TWO-WAY SERVICES

Full Two-Way Services require a large bandwidth for both upstream and downstream signals. Query and response message flow is of approximately equal duration in digital systems and for video modes. There is significant inbound flow of either normal or frame-stopped video. Thus, the available cable bandwidth is approximately equally divided to allow two-directional flow.

Since much of today's commercial and industrial information exchange makes use of digital communications, there is a growing need for interaction of computer data bases. It seems reasonable that some portion of the available channel space be made available for such use. The relative merits of transmitting information in video form (compatible with the TV picture structure) versus digital communications are not addressed here. Rather, a need for a system that will allow various organizations who already make use of teletype, audio-visual, and computer systems to communicate with other computers is identified.

However, it is felt that most of the full two-way services will be digital or single frames of video rather than the normal form of television video. Normal video utilizes a channel the full time while digital or frame-stopped video will permit time-sharing of a video by many users. With great use of normal television video only a few subscribers per cable can be served simultaneously. In a network connected to thousands of subscribers this is clearly too few subscribers, so that waiting times would be too long to be of practical use for normal television video.

SYSTEMS FOR POINT-TO-POINT SERVICES

In the point-to-point nets, connections are made between special subscribers. The telephone company's switched service is an example of point-to-point for audio. For cable system point-to-point services, the headend will probably provide message relaying between subscribers on the net. Interconnection between the point-to-point nets, and the telecasting net will also be possible, initially by manual interconnection.

The signals carried on the point-to-point nets may be continuous video, or single frames of video or digital data. These three modes would probably be handled differently at the headend switching center, although all are carried in a form compatible with standard, commercial broadcast TV channels. Normal video could be switched according to a prearranged schedule, controlled by a procedural discipline. Single frames of video could be grabbed and stored at the headend until they could be scheduled for delivery to their addressed destination. Digital data could also be time-division multiplexed onto an upstream line, stored, and forwarded with an address on the proper downstream line.

For the point-to-point services, the headend of the point-to-point net must contain some additional hardware to permit interconnection with the telecasting network; this would require that a number of manual connections be made possible at the master headend and subheadend of the cablecasting net. The headend would also require a larger signal processing capability of the type discussed under "Full One-Way Services" to process the increased number of video channels.

Normal continuous video would be used sparingly because of its bandwidth requirements. A single signal occupies the full 6 MHz bandwidth of a standard TV channel, and a single coaxial cable is limited by present day hardware technology to about 30 channels. The method of combining all 30 channels on one-cable is by means of frequency division multiplexing (FDM). On the other hand, single frames of video or digital data channels provide the opportunity for time-division-multiplexing (TDM) hundreds of channels simultaneously onto each of the 30 frequency division multiplexed channels.

The problem is cost for short distances. The cost of multiplexing equipment may be greater than the cost savings resulting from the use of multiple wire-pairs or coax. An inexpensive modulator/demodulator is needed and large-scale-integration (LSI) manufacturing techniques for digital data circuitry will hopefully bring down the price of the TDM modulator/demodulators in the near future. FDM requires oscillators and filters which do not as readily lend themselves to LSI implementation.

Commercial telephone equipment presently can combine 1,260 voice channels into a single video channel (6 MHz) for about $450 per channel.[40] This is the cost for a single, full-duplex FDM modem. Similar equipment could frequency division multiplex audio and lower bandwidth data signals onto the Washington cable television point-to-point net for approximately the same cost in small quantities. Large quantities could probably be built for under $200 each. An LSI TDM multiplexer could be produced in quantity for about $50 apiece. Thus a complete TDM/FDM modem could cost $150 to $250 in large quantity production. Display and input terminal hardware would be an additional cost, running from about $150 for black and white TV display and 12 button touchtone input, up to more than $500 for color TV and/or hardcopy display and a full alphanumeric keyboard input.

The TDM/FDM point-to-point system would require a computer at the head-end for TDM control. Depending upon the traffic density, such a computer would cost approximately $200,000 for 6000 subscribers, or about $370 per subscriber. Thus total system cost, aside from the distribution system, would cost approximately $800 per subscriber.

The Future

The technical growth potential of the point-to-point system lies in the development of new switching and modulation techniques. Sophisticated demand-switching on a per-channel basis could significantly increase the total number of available channels between any two points in the network. Such a system uses time division multiplexing. A system using these techniques was described above. This system is described in greater detail in MITRE M71-113.[41] We would expect that such a system will find application in urban centers in the years ahead.

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[40] GTE Lenkert, San Carlos, California, Multiplexing System Type 46A3.

In the future, cable services will be expanding in many cities.[42] In Figure B-14, the enclosed box at the left of the figure shows that cable television companies presently provide broadcast distribution of television and FM radio signals. It is expected that services will be expanded as depicted by the arrows from the service boxes in the figure.

SPECIAL APPLICATIONS

The special applications listed in this subsection are relatively low speed two-way communications applications that would go on the telecasting net. These applications are lower speed than full two-way which utilizes video bandwidth but these applications do send higher volumes of data than limited two-way does.

The MITRE Digital Cable Communication System

At the laboratories in Bedford, Massachusetts, MITRE has developed a system which allows subscribers who are connected to a

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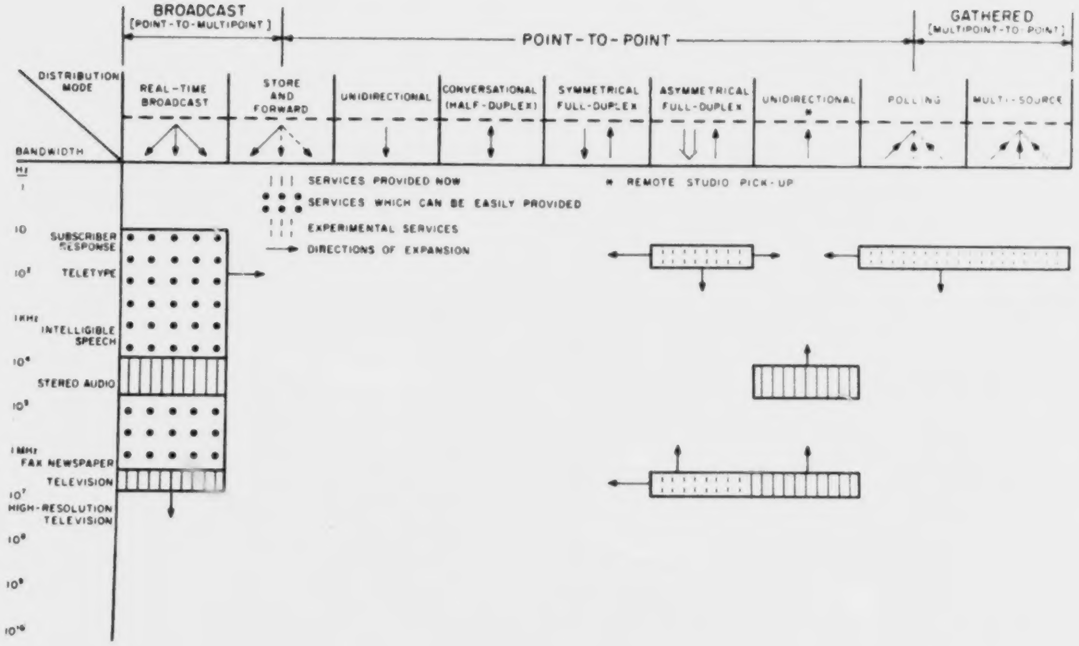
[41] Dolberg, C. D., "Digital Cable Communications," The MITRE Corporation, M71-113, Bedford, Massachusetts, January 1972.

[42] Stine, L. L., Plummer, D. M., Lambert, M. A., "Local Distribution of Telecommunications - A Perspective," The MITRE Corporation, M71-91, Bedford, Massachusetts, August 1971.



SOURCE: MITRE M71-91

FIGURE B-14
TELECOMMUNICATIONS SERVICES PROVIDED BY CATV SYSTEMS

cable system to communicate with each other using digital signals. This system will allow us to evaluate the many claims and theories about the interaction of channels carrying video and digital signals.

The design features for this system include:

(1) Intercommunication between any subscriber and any other subscriber, including the subscribers of other networks.

(2) Provision for the interchange of data between the digital cable communications system and those of other data systems, such as that found today in the telephone system.

(3) Standardization of data rate options (e.g., 75 x 2^n bits/second).

(4) Dynamic allocation of available capacity, providing subscribers the capacity needed, but only when it is needed.

(5) Future accommodation of more subscribers and higher data rates without minimal adverse impact on the service to current subscribers.

Traffic Control

In modern traffic control systems, a large number of detectors in the streets are used to sense the presence of vehicles. These detectors input information at a very low data rate, from 10 to 30 baud, to the communications system and then telemeter it via the cable system or telephone lines, to a central computer complex. In the reverse direction, the traffic control elements at the traffic lights act in response to control commands, also at low data rate, that are generated by the computer and sent out over the communications net.

The Urban Traffic Control System[43] in Washington uses individual frequency shift keying (FSK) transmitters at the traffic controller box on the street to communicate with the central computer. A transmitter is used for each wire loop detector (used for sensing vehicles) which is buried a few inches below the roadway surface; there are from one to eighteen transmitters at an intersection. These FSK signals from the transmitters are sent by frequency division multiplex (FDM) so that they can be economically transmitted over the telephone lines. There is an FSK receiver at each box which receives signals from the central computer to control the traffic light. The traffic lights at some intersections are equipped to respond to signals from buses that intend to either stop or go through the intersection; this feature could increase the flow of bus traffic. The traffic control system layout is shown in Figure B-15.

Individual FSK rates are under 20 baud and the signal from the wire loop vehicle detectors must be transmitted with less than 15 milliseconds time distortion; this timing requirement could be critical for any use of sampling in a time division system. For example, in an 8000 detector system (approximately the size of a complete Washington system) the sampling rate would have to be on the order of 500 KHz. If the city were divided into N sections, the sampling rate would drop to 500/N KHz. For time division multiplex, the digital

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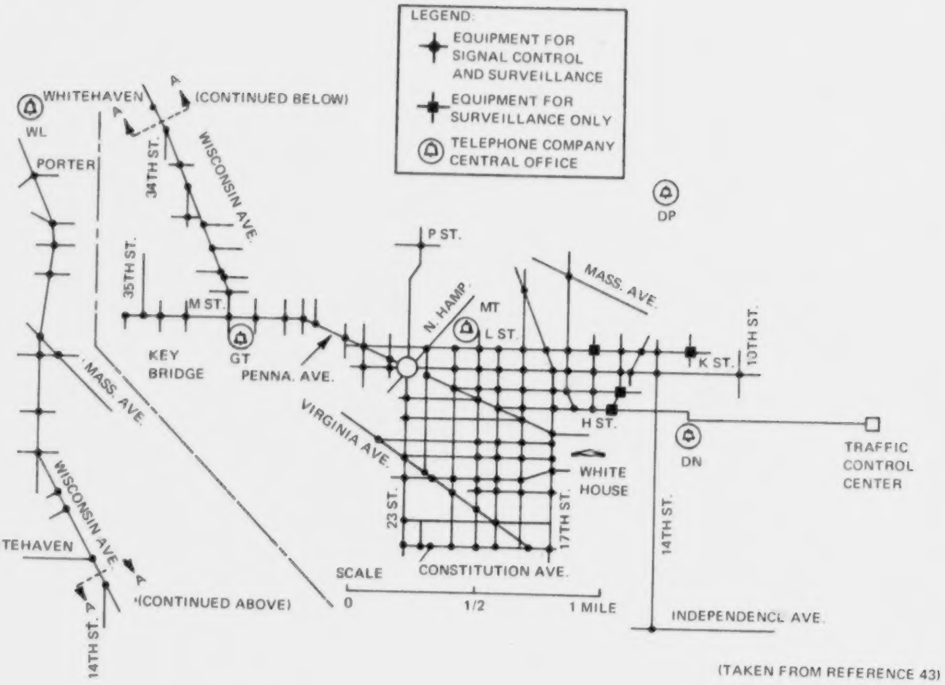
[43] Scott, J. E., "Urban Traffic Control Laboratory in the District of Columbia," National Telemetry Conference, '71 Record.



(TAKEN FROM REFERENCE 43)

FIGURE B-15
TRAFFIC CONTROL SYSTEM LAYOUT

communications scheme described in MITRE M71-113.[44] Digital Cable Communications System could be shared with other data communications users.

Based on discussions with equipment vendors, the same type of communications transportation scheme could be used on cable as in the telephone system described above except that the FSK carriers could be at frequencies somewhere in the cable band of frequencies. These FSK transmitters and receivers could be built for from 10% to 30% less than the cost of the modems used with twisted pairs depending upon quantity and the state of the art when procurement of the modems is begun.

An illustrative connection of cable to a traffic control system is shown in Figure B-16. This figure will be used to discuss some of the numerous tradeoffs that have to be made in the consideration of cable and traffic control. On the street side the interface unit accepts a number of low data rate inputs from the traffic detectors buried in the street. These inputs are in the 10 to 30 baud range. Similarly, the interface unit returns low data rates from the computer to the traffic light control boxes.

How many traffic intersections should one interface unit serve? If only one intersection is served, the TDM multiplexor/demultiplexor is probably unnecessary but an interface unit per intersection is required; FDM multiplex would be used as in present systems. If several

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[44] Dolberg, C. D., op. cit.

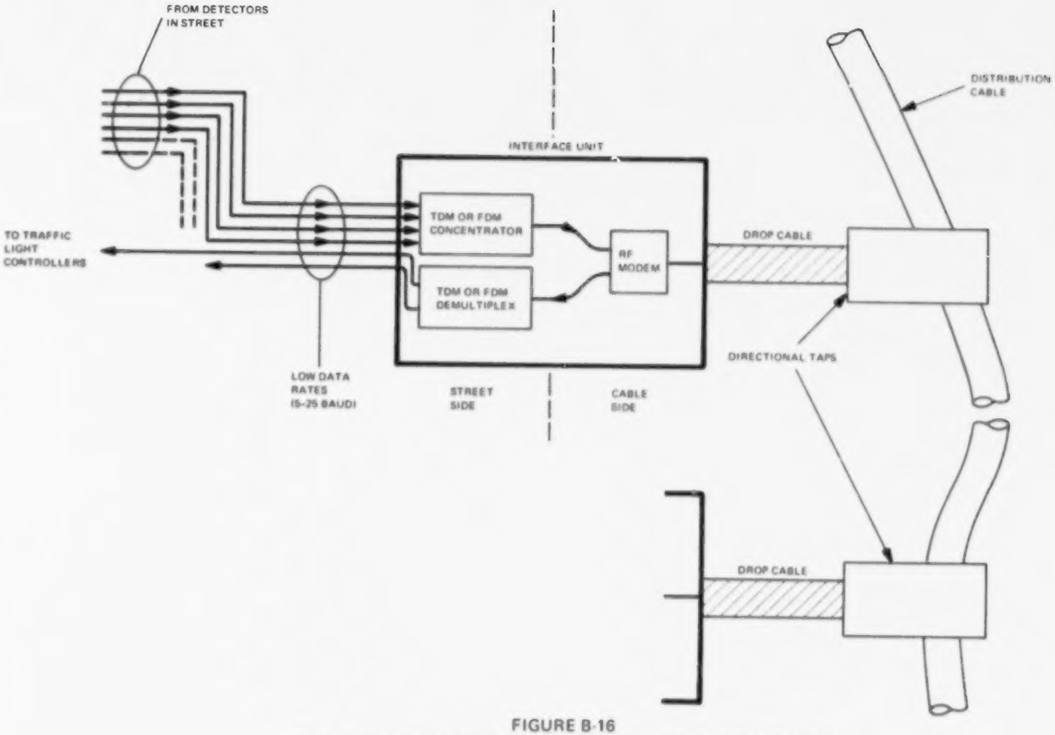

FIGURE B-16
ILLUSTRATIVE CONNECTION OF CABLE AND TRAFFIC CONTROL

intersections are served, a subnetwork of communications is set up to feed the single interface unit which would use TDM multiplex/demultiplex to efficiently transfer the multitude of low speed inputs. Thus a tradeoff is possible between a more costly interface unit serving several intersections and a lower priced unit at each intersection. Previous studies by a manufacturer of traffic control systems has indicated that an interface unit per intersection is best for interconnection with twisted pairs. No in-depth study has been made for the case of cable.

A survey of available off-the-shelf equipment for use as the multiplexors in the interface unit showed that the available equipment generally operated at standard telephone frequencies. In particular, FDM multiplexors operated in the 60 KHz to 108 KHz range.

Returning to Figure B-16, on the cable side, the interface unit would transmit at radio frequencies in the 5 to 300 MHz range. The path downstream to the traffic light controller would probably be a midband cable frequency. The upstream path would be in the 20 MHz to 30 MHz range. To cover all the street corners, this communication would be on the telecasting net instead of the point-to-point net which would not be expected to cover all intersections in an urban area.

Automatic Vehicle Monitoring

Techniques

The four basic approaches to AVM are:

(1) proximity sensing (PAVM), which locates vehicles by sensing their proximity to known "benchmarks" or sensors;

(2) electronic trilateration (TAVM), which locates vehicles by electronic ranging from a few fixed stations;

(3) dead reckoning (DAVM), wherein the vehicle keeps track of its location or its progress along routes known to the central computer and reports this information when queried by the computer. Even DAVM systems use PAVM for dynamic calibration and connection; and

(4) **LORAN** (LAVM), which uses **LORAN** signals relayed from the vehicles into a fixed receiver network for location calculations by the central computer.

All of these concepts require extensive wiring, i.e., connections between the fixed sensors, transmitters and receivers of the system and the central computer. A cable system has the potential to support these AVM concepts at reduced costs of communications as compared to telephone lines even where multiplexors are used. Reduced costs may make the difference between whether AVM systems are cost-effecitve or not, because such systems are now considered to be marginally cost-effective. Figure B-17 depicts an AVM and traffic light control system using a cable system.

A Proposed AVM System

A random routing PAVM scheme (random routing as opposed to fixed routing) uses street side sensors for identifying and tracking vehicles and is a candidate to make good use of the large bandwidth of cable.

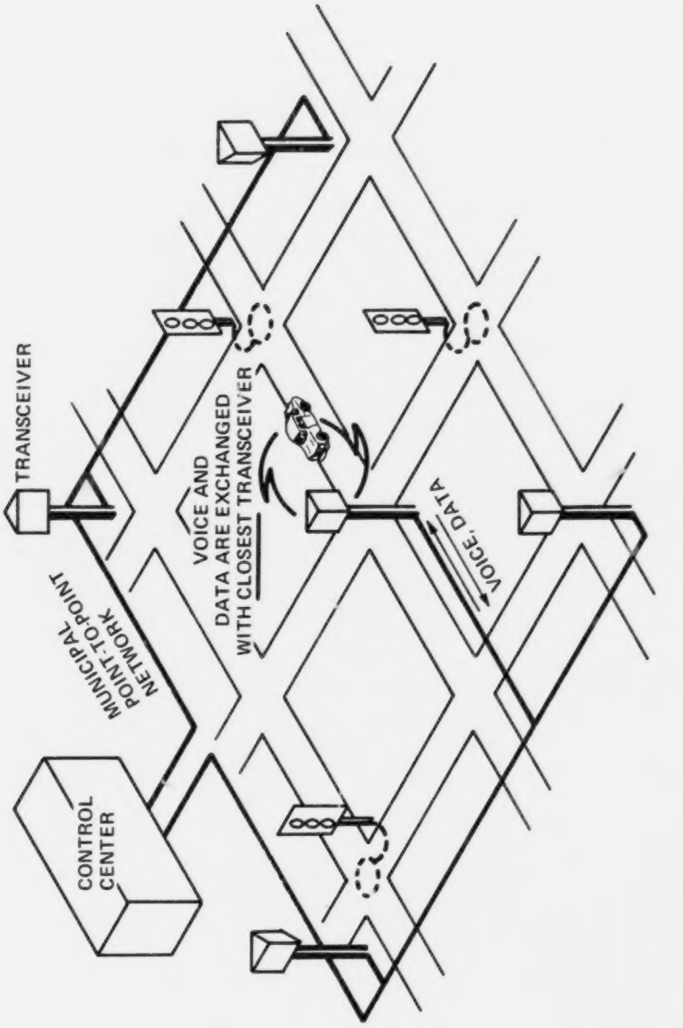
CONTROL CENTER
MUNICIPAL POINT-TO-POINT NETWORK
TRANSCEIVER
VOICE AND DATA ARE EXCHANGED WITH CLOSEST TRANSCEIVER
VOICE, DATA

FIGURE B-17
AVM AND TRAFFIC LIGHT CONTROL

The scheme uses a coded emitter located in each vehicle with sensors which are installed along the streets at every quarter of a mile or so depending on the accuracy requirements of the specific AVM application and the propagation characteristics of the area. These sensors could be installed in police boxes, fire call boxes, traffic light control boxes, and the like. The emitters would use a low powered VHF transmitter designed for a limited range of, say less than 100 feet. These can be operated without an FCC license on many frequencies and because of their limited range they do not contribute to spectrum congestion. The streetside sensors would connect with the cable to communicate with the central computer. The cable system conveniently offers wide bandwidth that would be required to frequency or time division multiplex the large numbers of sensor signals. Alternatively, a wideband time division multiplex scheme could be used to multiplex the sensor signals.

The random routing AVM for Washington, D. C. would be installed in the approximately 920 police call boxes of the District with the result of one sensor approximately every 1/4 of a mile.[45] The cable system's bandwidth could well be used to handle the 920 frequency multiplexed signals. All these signals could be carried on one 6 MHz cable channel. Even greater use of the available cable bandwidth would be made by a metropolitan Washington AVM which is estimated by MITRE to require 10 to 12 times as many sensors for the same 1/4 mile spacing and to use two to three 6 MHz channels.

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[45] Knickel, E. Ray, "A Vehicle Emitter - Street Side Sensor Vehicle Location System," Capital Scientific Corporation, July 1968, PB 180016 (Scientific Clearinghouse).

Multiplex Costs

The multiplex schemes used on telephone lines to reduce the cost of communications are applicable to the cable system. Currently, it is believed, after discussions with equipment vendors, that the cost of a multiplex for cable would be 10% to 30% less than the $120 to $180 cost for telephone line multiplexors depending on quantities and the digital technology available when the multiplexors are procured.

Summary of Cost Savings

The cable system has the potential to offer reduced communications cost to an AVM system because the telecasting cable is being shared by 30 channels of video plus additional channels for data and return video. This assumes that the multiplexors for the cable frequencies are no more costly than the ones at telephone frequencies. This assumption has been shown to be valid in the discussions with equipment vendors on the traffic light control application discussed earlier which is comparable to the AVM application discussed here.

The shared telecasting cable offers the brightest promise although a fully utilized point-to-point municipal services network cable might prove in if enough services could be shared. The AVM dedicated point-to-point net is at an inherent disadvantage in connecting all the AVM sensors since the point-to-point cable would not need to cover all streets while the telecasting cable would. To connect all the AVM sensors, the municipal point-to-point network would have to be extended in length which would increase the costs of the municipal point-to-point net for the AVM application.

AVM - Cellular Communications

A different approach to the integration of cable and AVM utilizes the concept of cellular communications. Cellular communications permits the reuse of frequencies in small cells over an urban area; this reduces frequency congestion. Figure B-18 depicts the use of cellular communications. It was taken from MITRE M71-110.[46]

Cellular communications can be used in applications other than AVM. In general, cellular mobile communications has been a name that has been given to a distributed communications system concept that utilizes low-power remote transmitters to increase total system capacity through multiple use of the same radio frequency in a geographical area of the size of Washington, D.C. In 1968,[47] it was estimated that 2.5 million mobile two-way radios were in use by government and non-government organizations. It has also been documented[48,49] that there is an

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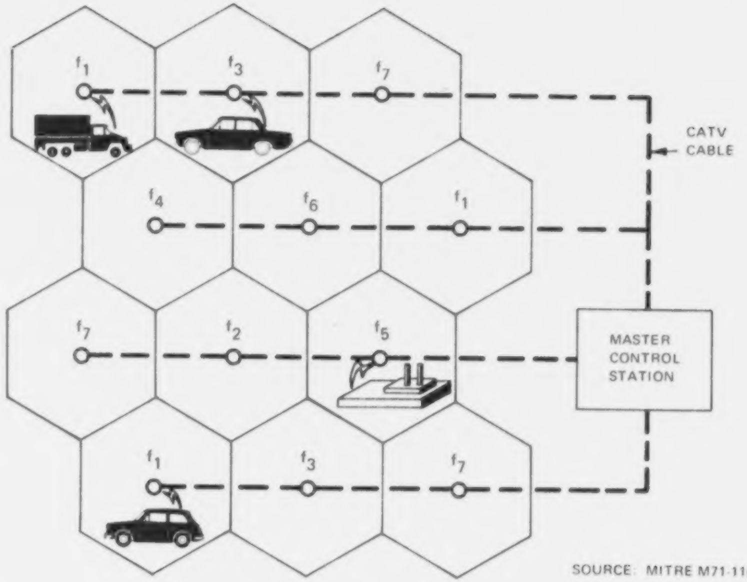
[46] Labonté, R. C., and Margulies, A. S., "Urban Mobile Communications and Vehicle Location Via Broadband Cable Networks," The MITRE Corporation, M71-110, Bedford, Massachusetts, December 1971.

[47] Staras, H. and Shiff, L., "Spectrum Conservation in the Land Mobile Radio Services," IEEE Spectrum, July 1971.

[48] FCC Final Report of the Advisory Committee for Land Mobile Radio Services, 1967.

[49] Eldridge, F. R., "Concepts For Improving Land Mobile Radio Communications," President's Task Force On Communications Policy, Appendix F, PB 184412, June 1969.



SOURCE: MITRE M71-110

FIGURE B-18
AVM USING CELLULAR COMMUNICATIONS

impending shortage of frequencies allocated to certain of the special two-way radio services such as those used by police, taxicabs, businesses, etc. This shortage will be felt earliest within large metropolitan areas such as Washington, D.C.

AT&T has been experimenting with cellular mobile communications in Philadelphia.[50] The experiment has been aimed at overcoming the problems of multipath reflections and the low transmitter power available at a mobile unit. A feature of the Bell scheme is a processor which switches calls from one cell to the next without the caller being aware of the switch.

Locating a mobile unit is necessary for establishing the radio link. A trilateration AVM scheme is used to locate the mobile unit. These locating and communications schemes would all be possible over the available capacity of cable systems.

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[50] "High-Capacity Mobile Communications System Proposed", Bell Laboratories Record, Vol. 50, No. 3, March 1972.

APPENDIX C

PROBLEMS OF CABLE SYSTEM OWNERSHIP

INTRODUCTION

The question of ownership is addressed in Section I of this report insofar as it influences the design of the physical facilities and the financial requirements to implement and operate the cable system. There are many dimensions to the ownership question that do not influence the technical design or financial plan in a fundamental way, but which must be considered by any group planning for an urban cable system.

These dimensions include national and local, political and social issues as well as questions concerning how or whether the system should maximize revenues and how these revenues should be distributed. The need for large capital outlays to finance cable systems inhibits certain desirable ownership strategies and also makes it difficult for city planners to commit themselves to some of the most desirable cable service possibilities. The extent to which the cable system should support established public programs, e.g., health, education and law enforcement, must be traded against the public demand for more entertainment and lower subscriber fees.

MITRE did not feel that the report would be complete without some discussion of these very important dimensions. This Appendix presents a discussion of the issues involved and summarizes the experiences of a selected set of cities in dealing with some of these issues. It attempts to present the points of view of cable operators, the FCC and various elements of the citizenry relative to system ownership questions. It also includes a set of references for use by readers concerned with specific issues and alternatives.

CABLE ISSUES AND CITIZEN ACTION

Cable television and broadband communications are coming to the nation's cities at a time when new forces and alignments are emerging in response to the conditions of modern American urban life. Prominent among these forces are: rising community consciousness; increasing interest in the concept of community control; and a growing recognition of the central role played by modern communications technology in molding individual and community consciousness, providing a vehicle for effective expression, and determining the flow and distribution of power.

These forces are manifesting themselves with increasing pervasiveness, sophistication, and effectiveness in a broad range of urban communications issues. Local and national citizens groups now file briefs in response to Federal Communications Commission Notices of Inquiry on abstruse communications problems that formerly attracted little or no attention from any parties other than those with an economic interest in the outcome. Broadcast stations in larger cities often find that, when their licenses come up for renewal, they are faced with numerous challenges to their right to be re-licensed by citizens groups who claim that the stations do not meet adequate criteria for operation in the public interest. In other instances, non-profit groups have gone to court to secure the right to buy time on commercial TV stations to broadcast their views on controversial issues of public policy.[1]

Citizens' groups are also entering the decision-making process in the buying and selling of television stations in major markets. Further, they are raising the threat of resort to the courts in these and other types of cases when the groups believe that the Federal Communications Commission has not adequately defended the public interest. A recent landmark case was that of the sale of five TV stations by Time, Inc., to McGraw-Hill. The sale would have given McGraw-Hill ownership of three VHF stations in the top 50 markets. FCC policy, designed to promote diversity of ownership, prohibits ownership of more than two VHF outlets in the top 50 markets without "a compelling public-interest showing". The Commission held that McGraw-Hill had satisfied this criterion and OK'd the sale. A consortium of civic and community groups, maintaining that no such showing had been made, filed suit in the U.S. Court of Appeals in Washington to overturn the Commission's approval of the transaction.

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[1] For citizens' groups filings on communications proceedings before the FCC, see, for example, the scores of filings by such groups in FCC Dockets 18397, 18397A, 18892, and 18894, the dockets leading to FCC's Cable Television Report and Order (FCC 72-108, Fed. Reg., Vol. 37, No. 30, Part II, Feb. 12, 1972, p. 3252). License renewal challenges have been numerous and have been extensively reported in the press; see various issues of Broadcasting, 1970 to the present. Two court cases successfully challenging the refusal of TV stations to sell time to non-profit groups for the broadcasting of viewpoints on controversial public issues are U. S. Ct. App., D.C. Cir., No. 24,492, Business Executives Move for Vietnam Peace v. F.C.C., and No. 24,537, Democratic National Committee v. F.C.C., both decided Aug. 3, 1971. On the general subject of increasing citizen effort to secure access to broadcast media, see "The Struggle Over Broadcast Access," Broadcasting, two parts, Sept. 20 and 27, 1971.

Negotiations ensued in which Time-Life agreed to sell only four of the five stations to McGraw-Hill, reducing the latter's holdings in the top 50 markets to two. McGraw-Hill agreed to establish minority advisory councils in each of the four markets in which they were acquiring stations; to involve these advisory groups "from the beginning in the development of local programming related to minorities"; to finance and produce substantial numbers of programs relating to minority interests and minority cultures, many of them in prime time; to make one-minute spots available for statements or announcements by local persons and groups, with the station exercising no control over what is said; and to increase the hiring and training of minority persons in technical, managerial, sales, and professional categories.[2]

Cable has become both a catalyst of, and a central focus of, this new citizen interest in communications. As the most visible part of the coming communications revolution, it has exercised a wide fascination. The possibility that various potentials of cable could be partially or wholly lost through shortsighted arrangements has been recognized, and has aroused interest and concern. The interest of local groups and individuals has been fostered and reinforced by the participation of a number of national organizations in the dialogue. These organizations include, among others, the Ford Foundation, the Urban Institute, the United Church of Christ, the American Civil Liberties Union, the National Citizens Committee for Broadcasting, the National Education Association, Black Efforts for Soul in Television, the Alternate Media Center and other groups involved in the production and dissemination of half-inch videotapes, and Publi-Cable, a consortium of civic and educational groups. Through numerous public conferences, through dissemination of literature, through testimony at public hearings, and through visits by their officials to cities where cable franchising is being considered, such groups have raised public awareness of the problems involved in bringing cable to urban centers, and of possible alternative courses of action. Further information has become available through publications such as the Report of the Sloan Commission on Cable Communications, various studies published by the RAND Corporation under grants from the Ford and Markle Foundations, and several books and booklets distributed by civic groups and commercial publishers.[3]

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[2] "McGraw-Hill sets record for concessions to minorities," Broadcasting, May 15, 1972. See also "Any ceiling now in sight on the price of settling sale protests?" Broadcasting, May 29, 1972.

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[3] Sloan Commission on Cable Communications, On the Cable: Report of the Sloan Commission, New York; McGraw-Hill, 1971, 256 pp., $2.95; RAND Corporation, various publications on cable, list available from RAND, 1700 Main Street, Santa Monica, Calif. 90406. Other publications of interest include: Monroe Price and John Wicklein, Cable Television:

(Continued next page)

The impact of citizen interest in cable matters is already widely apparent. For example:

-- In Nashville in 1971, the Metropolitan Nashville Educational Association spearheaded a broadly based civic movement that frustrated the efforts of the City Council to hasten through an ordinance granting a 45-year exclusive franchise to a politically powerful local group, against the recommendations of the City Planning Commission. When the Council passed the franchise despite civic protest, the Mayor vetoed it; a number of councilmen lost their seats in the ensuing election; and the city is now conducting studies leading to the drawing up of a comprehensive ordinance preparatory to receiving and considering competitive bids.

-- In Rhode Island, a "Community Cable Consortium" was organized in April 1972 under the auspices of the Rhode Island Council of Churches. It will bring citizens of the state together "to demand minimum requirements of any licensee, and exert some control over the local licensee in behalf of the local

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3 (Continued)
A Guide for Citizen Action, Philadelphia: Pilgrim Press, 1972, 160 pp., $2.95: Theodore Ledbetter, Jr. and Gilbert Mendelson, The Wired City: A Handbook on Cable Television for Local Officials, Washington: Urban Communications Group, 1972, 87 pp. $2.95; Ralph Lee Smith, The Wired Nation, New York: Harper and Row, 1972, 128 pp., $1.95; Charles Tate, Ed., Cable Television in the Cities: Community Control, Public Access, and Minority Ownership, Washington: Urban Institute, 1971, 184 pp., $3.95; National Education Association, Schools and Cable Television, Washington: NEA, 1971, 66 pp., $2.25.

community." In creating the Consortium, the Council stated that "such a communication instrument can profoundly affect society," and that if churches remain inactive they will not be able to have an influence on the course of social change.

-- In San Jose, California, a citizen's group is demanding that the franchisee, TelePrompTer Corporation, expand the capacity of its 12-channel system to make one or more channels available for public access. TelePrompTer, operating under a franchise that does not require more than 12 channels; with all of its channels in use for retransmission of broadcast signals and for program origination controlled by the company; and faced with a cost of retrofitting for additional channel capacity that it estimates at $4 million; has to date refused to accede to the demand. The citizens' group thereupon collected 1,800 signatures on a petition, more than enough to put the issue on the ballot for decision by the voters in November 1972.

-- In Washington, D.C., the city that serves as a model for this Report, the Institute for Policy Studies called a conference for June 1972 to lead to the creation of a citizens' group to become involved in the franchising process. Noting that Washington's population is well over 50 percent black, the call to the conference stated, "The record of the existing white broadcast media's service to the non-white community cannot be duplicated in this new technology. And black people have no evidence that any change will come about unless they are centrally involved in the decisions that are being made. Because of these facts, a method must be found to broaden the involvement of citizens and community people in the questions of cable television policy and ownership which will--to a large extent--decide what comes over your home TV screen during the next few years."

Among both civic groups and Municipal officials, attention has increasingly focused on the problem of the ownership, and the cluster of issues that are directly or indirectly affected by ownership. These issues include:

-- What are the possible or likely consequences for communities and municipalities, of the swift consolidation now taking place in the cable industry, in which more and more of the nation's cable systems are passing into the ownership of fewer and fewer hands?

-- What are the consequences for municipalities and communities, of the parallel trend by which cable systems are increasingly owned by companies that own or control other communications media?

-- In choosing a franchisee, should municipalities give preference to a locally-owned company over a company that is part of a multi-system or multi-media conglomerate?

-- In larger cities, should one city-wide franchise be granted, or should the city be subdivided into several geographic areas, each with a separately-franchised cable system?

-- Should municipalities consider franchising non-profit groups or civic consortiums, to own and operate cable systems?

-- Should the city consider owning the system itself? What are the advantages and disadvantages of Municipal ownership?

-- Who should be the beneficiaries of the revenues that accrue from the operation of cable systems?

-- Assuming that cable is not a common carrier and that the cable operator will therefore be free to select at least some of the material that is shown over cable's many channels, who will do this choosing, and what will be chosen? Will it adequately reflect community, minority, and special interests?

-- How much of the revenue generated by cable systems, will be devoted to the purchase and financing of programming?

-- Who will have access to the cable system, and on what basis? If money is available to finance some original programming, who will receive it?

- How should communities and minorities within urban centers be involved in cable? If they are to have ownership participation, how is such participation to be financed? If not, what arrangements will provide them adequate access to both the facility and to the decision-making process by which it is run?

-- Should it be an objective of communities and municipalities to make cable service available to most or all homes in cities, regardless of income level? If so, what ownership structure might best achieve this objective?

Full treatment of all these questions and issues lies beyond the scope of this report, and in fact would constitute a book-length report of its own. In general, it should be noted, first, that no one path or choice in the field of ownership is clearly superior to others for all municipalities and all situations. Second, no one choice provides all the benefits that municipalities and communities will wish to achieve; each possible choice precludes full realization of certain attractive features of alternative arrangements. Maximization of goals and objectives that are most important for the individual city and its communities and residents, must be the objective in the decision-making process in cable ownership.

With these facts in mind, some salient features of the problem can be sketched and certain major alternatives discussed.

PATTERNS OF INDUSTRY GROWTH

The cable industry is presently undergoing a process of swift consolidation, in which a relatively small group of firms are serving an ever-increasing proportion of all U.S. subscribers, through ownership of many systems in various locales. In 1970 the top ten MSO's (multi-system operators) served 29% of all U.S. subscribers; in 1971, 34%; in 1972, 40%, with the top twelve serving half of all subscribers.[4]

Some multi-system operators have no business activity other than the ownership and management of cable systems. Others are companies involved in the ownership and management of other types of media. Others own cable equipment manufacturing companies as well as cable systems. Still others are conglomerates that own other business enterprise having little or no relationship to cable.

Several forces lie behind this consolidation of ownership. One is the demonstrated profitability of many cable systems, particularly those located in areas of poor over-the-air reception, and the simple desire of investors to acquire profitable enterprises. Another is fear on the part of other media interests of competition from cable, and a corresponding desire to buy in as a hedge against the future. A third is the difficulty that some smaller companies and systems have experienced in securing financing for the updating and expansion of their operations. In many instances, such firms are selling their assets to larger companies more in order to meet short cash positions than to realize capital gains. A fourth factor is the high cost of wiring urban areas, which is forcing consolidations in order to create companies with sufficient size, assets, and credibility to lending institutions, to be viable bidders for such franchises.

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[4] Television Digest, July 5, 1971; Broadcasting, March 20, 1972. See also CATV, May 15, 1972.

Breaching of cable's urban frontier is a project that social scientists, urban planners, and community groups view with enthusiasm, and bankers and lending institutions view with caution. In the small towns and rural areas where the cable industry got its start and where most of its physical plant is still located, cable systems can be built for modest investments; their basic function of retransmission of over-the-air broadcast signals is well defined; and profitability has been amply demonstrated. In urban areas, construction costs are high; the types of services that such systems will deliver, and who will pay how much for them, are still question marks; and profitability has yet to undergo the test of experience. "The real shape of CATV in the nation's cities is still wholly unknown," the cable industry trade magazine TV Communications said in its January 1972 issue. "Nobody, including the industry's top MSO executives, knows exactly what operations will be like ten years from now in our wired nation. The industry has very little idea of the economic feasibility of the many things that it will be able to do."

These unknowns weigh heavily with banks that are called upon to supply short-term cash for urban cable construction, and insurance companies and other lending institutions that serve as sources of [illegible]-term financing. "The financing problems of the cable business are complicated by the fact that the kind of construction that will take place over the next ten years is going to be, in my view, totally different from what has been done in the past," the vice president of a New York brokerage house told a National Cable Television Association seminar on cable financing in 1971. "The cable industry is going to be building types of systems that have never been built before. These new systems will not be able to rely on the conventional off-air or imported signal product for their success."[5]

Under these circumstances, funding sources are strongly inclined to play it safe. "Basically, I think commercial banks are going to be very reluctant to provide money for new companies barely starting," a ranking officer of one of the nation's largest commercial banks told the seminar, "...we have other alternatives in multiple system operators with proven records."[6]

The pattern of urban cable development will probably be decisively molded by these policies of lending institutions. It was forecast at the seminar by an officer of the investments department of a large insurance company that has been doing some selective financing of cable instruction by MSO's. There will be, he said, "a fairly high degree of merger consolidation activity within the industry," resulting in the emergence of a "group of well managed companies with sufficient resources to participate in continuing long term industry growth."

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[5] Toward the Wired Nation: The Financial Implications of Developing Cable Communications, Transcript of a Seminar Sponsored by the National Cable Television Association, June 30, 1971, remarks of James M. Graves, Vice President, CBWL-Hayden Stone, p. 21.

[6] Op. cit., remarks of Roger J. Schultz, Assistant Vice President, Morgan Guaranty Trust, p. 35.

Eventually "a stage of maturity" will be reached, "with large, stable companies dominating the field."[7]

Such a course of events raises many important issues of communications policy which are beyond the reach of municipalities. The question of how much concentration of ownership or control is "enough" --or "too much"--and the development of criteria on which such decisions can be based, are problems that must ultimately be dealt with at the Federal level.

In the meantime, present trends raise problems for municipalities that must be termed serious. Competent local private entrepreneurs, and non-profit community groups or civic consortiums, who may wish to become bidders for urban franchises, may be unable to secure financing, while large multi-system operators may be granted access to funds. This narrows the city's choice of viable franchisees for reasons that may have little to do with their relative merits, and robs the city of the widest possible selection of applicants from which to choose.

To overcome this problem, Municipal governments may wish to encourage their local financial communities to consider supporting qualified local applicants, so that such applicants can compete with large MSO's in franchise competitions. City governments may also wish to take up with their Senators and Representatives in Washington, the question of

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[7] _Op_. _cit_., remarks of Guy C. Roberts, Investments Department, Massachusetts Mutual Life Insurance Company, p. 9.

Federal legislation that would provide loan guarantees to responsible local private firms and non-profit groups that wish to bid for cable franchises, thereby giving cities a wider selection of applicants that can be considered on their merits.

A further question that municipalities should explore in considering the franchising of a multi-system operator, is the relationship that the local cable company will bear to the parent firm in two areas--decision-making with regard to local operating policies, and programming on the channels over which the operator will exercise control. Sufficient autonomy to permit the local operator to adapt his system to local needs and conditions, and clear agreements about the nature and amount of financing that the system will provide for the support of local programming, should both be written into the franchise. In cases in which the parent company plans to purchase programming for distribution throughout all the systems that he owns, the nature of the programming and its suitability for local use should be studied and discussed.

Another issue that must ultimately be resolved at the Federal level is cross-ownership of cable and other communications media. As of early 1970, about 42 per cent of the cable television industry was owned by other media interests, with broadcasters owning 30 per cent, newspapers owning 7 per cent, and telephone companies owning about 5 per cent.[8]

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[8] "Cable Television Fact Sheet," National Cable Television Association, April 1972.

The Federal Communications Commission has already taken several steps in this field. In a proceeding of considerable importance, the Commission ruled in 1970 that telephone companies cannot own and operate cable systems within the areas in which the companies provide telephone service. Divestiture was required. This ruling had the effect of stopping and reversing a trend of telephone company involvement in cable communications.[9]

In the broadcasting field, FCC has banned ownership of cable systems by TV networks. It has also banned ownership of cable systems by TV stations serving the same community in which the cable system is located.[10] The White House's Office of Telecommunications Policy, however, has made it clear that it does not favor this latter restriction,[11] and in this view it is strongly supported by both the cable and broadcasting industries.

FCC has made two other ownership proposals. One would limit MSO's to ownership of no more than 25 cable systems in the top 100 population areas if the company has ownership interests in more than one TV, two AM or FM radio stations, or two newspapers.[12] Another would ban cross-ownership of newspapers and cable systems in the same market.[13] FCC's proposal to ban newspaper-CATV ownership, however, is reported to be in disfavor with the Cabinet-level committee appointed by President Nixon in 1971 to study cable TV and make long-range policy recommendations,[14] and battles are in prospect.

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[9] FCC Docket 18509, Final Report and Order, Feb. 4, 1970, 21 FCC 2d 307. For a more detailed discussion of the role of the telephone companies in cable communications, see Ralph Lee Smith, The Wired Nation, New York: Harper & Row, 1972, Chap. 5, "Mysterious Ma Bell," pp. 64 ff.

[10] FCC Docket 18397, Second Report and Order, July 1, 1970, 23 FCC 2d 816.

[11] "Whitehead likes closer cable-broadcaster ties," Broadcasting, Oct. 18, 1971.

[12] FCC Dicket 18891, Notice of Proposed Rule Making and of Inquiry, July 1, 1970, 23 FCC 2d 833.

[13] FCC Docket 18397, Notice of Inquiry and Notice of Proposed Rule Making, December 13, 1968, 15 FCC 2d 417.

On crossownership policy municipalities will have little direct say. If they have strong views on the subject, they may wish to follow FCC's ongoing proceedings and make input through the filing of statements and briefs. Actual experience with crossownership and its effect, if any, on programming, would be of particular interest to the Commission, as would opinions of Municipal governments on the effect of crossownership on the diversity of broadcast fare available to local citizens.[15]

THE COMMON CARRIER ISSUE

The cable industry consists of three separate components. They are:

(1) The cable system itself;

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[14] "One more time," editorial in Broadcasting, Oct. 25, 1971. The cabinet-level committee is also reported to oppose FCC's ban on crossownership of TV stations and cable systems in the same market, ibid.

[15] Two extensive studies of ownership issues, both by Stephen R. Barnett, Acting Professor of Law at the University of California, are: "Cable Television and Media Concentration, Part I: Control of Cable Systems by Local Broadcasters," Stanford Law Review, January 1970; and FCC Dockets 18110 and 18891, Reply Comments of Stephen R. Barnett, August 16, 1971. Barnett opposes crossownership of cable systems and newspapers in the same market. Another opponent of crossownership is Dr. Harvey J. Levin, Senior Research Associate of the Center for Policy Research and Professor of Economics at Hofstra University; see FCC Docket 18110, Reply Comments of Dr. Harvey J. Levin. Most of the filings on these dockets were made by cable companies, broadcasters, and newspapers; they all favored crossownership.

(2) Materials transmitted over the cable facility--visual programming, non-visual programming, and data transmission; and

(3) Manufacturers of cable system hardware.

It has been proposed that these three entities should be separated each from the other, and that no owner should be able to have a commercial interest in more than one.

The rationale for separation of cable system ownership from ownership of hardware concerns is basically anti-trust. According to proponents of the separation, a hardware manufacturer who owns cable systems has captive customers with whom he can deal with minimum exposure to competitive market conditions, and cable systems affiliated with manufacturers are not really free to shop for the best hardware at the best price.[16]

The proposal to separate system ownership from ownership of content has additional ramifications relating to freedom of access and freedom of speech. Proponents of separation believe that it is not in the public interest for the same party to own the facility, and to have the power of decision over what it is to transmit. According to advocates of separation, if the system owner is allowed to program the entire content of the facility, his power to exclude other users, and to exclude the dissemination of information not to his liking, is too great. If he is allowed to program part of the content of the facility, then his motivation will be to reduce the number of other users, so that as many persons as possible will be watching the operator's own programming or using the operator's own visual or nonvisual services. Conversely, if the operator is removed completely from the programming and content business, and instead is in the business of leasing channels to others, then his motivation will be reversed, and he will seek to sell channel space to as many users as possible.

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[16] The rationale is more fully developed in Ralph Lee Smith, "Ownership Policy and the Cable Industry," Yale Review of Law and Social Action, Spring 1972, p. 269.

Implementation of this proposal would have the effect of turning cable systems into common carriers. Like the telephone companies, they would provide a wire facility, but would exercise no control over who uses it or what is transmitted over it.

The common carrier issue has created interesting alignments. Those favoring common carrier status for cable include liberal political groups and civil liberties organizations such as Americans for Democratic Action and the American Civil Liberties Union, who favor it on grounds of free speech.[17] They are joined by a number of business firms and business groups, who would prefer that cable be a common carrier in order to guarantee that they will have full access to the medium at fair, nondiscriminatory rates for commercial purposes.

Thus, in a wide-ranging filing with FCC on its cable rulemaking proceeding, the Industrial Electronics Division of the Electronic

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[17] FCC Docket 18397, Filings of Americans for Democratic Action, June 5, 1969; American Civil Liberties Union, September 5, 1969. The Illinois Division of the American Civil Liberties Union has drafted a model Municipal ordinance for regulating cable as a common carrier; see Soapbox Television: Model Code of Regulations, Cable Television - Broadband Communications, ACLU, June 1971.

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Industry Association proposed a nationwide cable facility organized as a common carrier.[18] In a discussion of the future of cable, a high official of General Electric Company recently said, "The broadband cable carrier would not be responsible for program material any more than the present telephone companies are responsible for the traffic carried on their lines. The cable carrier simply provides the facility."[19] In its deliberations on the future of cable, the cabinet-level committee appointed by President Nixon has also been considering common carrier status, and is said to be looking favorably on it as a path of growth for the industry's future.[20]

Opposition to common carrier status comes from equally diverse interests. They include many segments of the educational community, who believe that channels should be provided without charge, rather than on a lease basis, for educational purposes,[21] and the National Cable Television Association, representing industry interests who stand to profit from the involvement of cable operators in the dissemination of programming.[22]

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[18] FCC Docket 18397, Filing of Industrial Electronics Division, Electronic Industry Association, October 29, 1969. This filing has been issued by IED/EIA under the title "The Future of Broadband Communications."

[19] Letter, R. P. Gifford, General Electric Company, to MITRE, December 8, 1971.

[20] Joint Council on Educational Television, News, January 1972, p. 5ff.

[21] See, for example, National Education Association, Schools and Cable Television, p. 9.

[22] "NCTA opposes ACLU petition," National Cable Television Association Bulletin, March 7, 1972.

As a practical matter, no cable system has yet been franchised on a common carrier basis, and FCC's new cable rules permit operator involvement in content. In fact, in 1969 the Commission issued a rule requiring operators of systems serving more than 3,500 subscribers to engage in program origination.[23] The rule was challenged by a cable operator, and a 5-to-4 decision in June, the Supreme Court upheld the Commission's ruling.[24]

The purposes of common carrier regulation are at least partially fulfilled through FCC requirements that cable systems in the top 100 markets provide a public access channel, and by requirements in local franchises that cable operators lease channel space to all comers in accordance with demand. The system design described in this report assumes that the operator or franchisee will be involved in providing programming, while at the same time providing leased channels for all others who may wish to use the system. In the future, however, municipalities should be aware of the strong likelihood that the direction of Federal policy in cable may be toward removing the cable operator from the field of programming. With this in view, leasing of channels, and strong encouragement of community groups, commercial interests, and others, to make use of them, will favor a type of cable development that both fosters diversity and accords with likely future movements in Federal policy.

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[23] FCC Docket 18397, First Report and Order, October 24, 1969, 20 FCC 2d 201, stay denied, 20 FCC 2d 899 (1969), recon. denied, 23 FCC 2d 825 (1970).

[24] U.S. Ct. App., 8th Cir., No. 20,439, Midwest Video Corp. v. U.S.A. and F.C.C.; "High Court Backs F.C.C. on Cable-TV," New York Times, June 8, 1972

INVOLVEMENT OF MINORITIES

Blacks and other minorities have been all but excluded from ownership of U.S. broadcast media. Of more than 900 commercial TV stations in the U.S., none is black-owned, and blacks own only about 17 of the 350 radio stations that cater to black audiences. So far, of more than 2750 cable systems serving about 4,500 communities in the U.S., none is wholly owned by blacks.[25] Minorities view cable as an unanticipated opportunity both to participate in ownership of media and to own an important communications facility serving their own residential areas in cities, and minority spokesmen are determined that the opportunity should not be lost.

In 1971, the Urban Institute, a nonprofit research organization studying the problems of the Nation's urban communities, recommended local ownership of cable television systems by ethnic groups, neighborhood-based companies, and organizations within the boundaries of major cities. The Institute stated:

> "Imagine television and radio systems where blacks could program for blacks, Chicanos for Chicanos, Indians for Indians, and Puerto Ricans for Puerto Ricans -- a system that can give the community a communications voice as well as the income and profit that the system receives for providing this service ...If blacks, Chicanos, Puerto Ricans and other racial minorities who reside in the central city ghettos lay claim to those systems that will operate in their communities, ownership and control by outsiders could be seriously challenged and prevented."[26]

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[25] "Blacks Seeking Control of Big-City Cable TV Face Uphill Struggle," Wall Street Journal, December 29, 1971.

[26] Charles Tate, Ed., Cable Television in the Cities: Community Control, Public Access, and Minority Ownership, Washington: Urban Institute, 1971, pp. 3, 15.

Minority groups have two principal motivations in seeking ownership of cable in black city neighborhoods. One is assurance that blacks will have access to the medium, and also assurance that, since cable has not become a common carrier and the operator therefore exercises some choices in the selection of programs, this power of program selection be in local black hands. A second motivation is to assure that the revenues, training opportunities, and economic advantages generated by cable as a commercial entity accrue to the black community in which the cable system is located.[27]

The principal obstacle faced by black groups in their quest for cable ownership is the high cost of cable construction in urban areas and the near-inaccessibility to local black groups of sizable financing. For this reason many leaders of the cable industry have been urging blacks to consider settling for guaranteed access to urban cable systems, and concentration of efforts on producing good and valuable programming for black communities. The financing picture, the president of a cable MSO recently stated, "does not bode well for local citizens' groups in a major market community, and particularly for minority groups. I wish it were otherwise. But I think these are the kinds of attitudes held by existing funding sources for the industry." He therefore urged blacks to forego ownership and direct their energies to programming, which he described as "people intensive" rather than capital intensive.[28]

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[27] The issues are well presented in "The New Communicator and the Public Interest," CATV, a roundtable dialogue among Charles Tate of the Urban Institute; Theodore S. Ledbetter, President of Urban Communications Group and editor of Black Communicator; William D. Wright, national coordinator of Black Efforts for Soul in Television; and Snowden A. Williams, Jr., Associate Director for Innovations, Office of New Communities Development, HUD; in CATV, May 15, 1972.

Black leaders, however, have not been willing to accept access as a substitute for ownership, and there seems little doubt that ownership patterns that include blacks and other minorities will emerge in many urban centers. Because of the relative inaccessibility of funds for black groups and community groups, new arrangements will have to be created by cable operators and by municipalities. One such arrangement has been jointly proposed to the City of Dayton, Ohio by Cypress Communications Corporation, a California-based MSO, and Citizens Cable Corporation, a company wholly owned by residents in the predominantly black Southwest area of Dayton. Under the plan, the two companies would share ownership of a proposed $2 million cable system in the Southwest area, while Cypress simultaneously built a $5 million plant for the remainder of the city. Citizens Cable would pay $500,000 for its 50% interest, but $400,000 of that amount would be loaned by Cypress on a long-term, low interest basis, repayable over a ten-year period. Citizens Cable would finance the balance of its participation by a registered public sale of 10,000 shares of its voting stock, to minority residents only, at $15.00 per share. These stockholders would elect nine of the eleven directors of Citizens Cable Corporation.[29] In June 1972 Cypress announced a similar proposal for construction of a cable system in Stockton, California.[30]

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[28] _Toward the Wired Nation_, Remarks of Amos B. Hostetter, Vice President, Continental Cablevision, Inc., pp. 37, 44, 49.

The system described in this report is basically a unitary plan for wiring an urban center. It can be adapted, however, either to separate franchising of several areas, or to an arrangement whereby a single franchisee grants substantial autonomy to community and neighborhood groups to operate the part of the system that falls within their boundaries.

MUNICIPAL OWNERSHIP

Another alternative in cable system ownership is ownership by the municipality itself. There are eighteen municipally-owned cable systems in the United States, most of them in small towns, and many of them established during the early days of cable TV when municipalities took an active interest in bringing broadcase TV reception to their citizens. One of the largest, the system in Frankfort, Ky., provides eleven channels of service, including one local origination channel, for about 4,000 subscribers. Its installation fee of $5.00

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[29] "Plan for Minority Participation in a Cypress Cable System in Dayton, Ohio," Cypress Communications Corporation, February 23, 1972, booklet.

[30] "Stockton citizens let in," Broadcasting, June 19, 1972.

and monthly subscriber's fee of $2.50 are apparently the lowest in the U.S. At these fees the system generates a surplus, which it is required to contribute to local charities. One of its major projects has been help toward the financing of a new YMCA building in the city.[31]

Municipal ownership continues to be of interest in certain smaller towns and cities, and recently it has been increasingly discussed as an ownership alternative in major urban centers.[32] In Detroit, a cable TV study committee composed of prominent citizens appointed by the Detroit Common Council issued a report in May 1972, recommending that the City create a special public authority, governed by a nine member board appointed by the Mayor with the approval of the Council, to build and own the proposed cable system in that city. Actual operation could be contracted to private interests, under the policy directives of the public authority. Construction would be financed by bonds issued by the authority, which would be paid off from revenues from subscribers and from the sale of advertising on cable system channels. Under the plan, the city would be divided into five areas, with each area having a board elected by subscribers that would handle some of the programming for that area.

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[31] For information on municipal ownership see: Steven R. Rivkin, Shaping Ownership and Control in the Cable Television Industry, Sloan Commission on Cable Communications, February 11, 1971, Appendix C; Louis Schwartz and Robert A. Woods, "A Marriage Proposal: Cable Television and Public Power," Public Power, two parts, November-December 1971 and January-February 1972; James C. Webster, "Local Public Power Systems Operate Municipal CATV," Public Power, January-February 1972; Walter S. Baer and Donald H. Camph, "Ownership Alternatives," in L. I. Johnson, W. S. Baer, R. Bretz, D. Camph, N. E. Feldman, R. E. Park, R. K. Yin, Cable Communications in the Dayton Miami Valley: Basic Report, R-943 KF/FF, RAND Corporation, January 1972.

[32] "The New Pot of Gold? Cities Look at Cable," TV Communications, May 1972.

The Committee's recommendations stemmed from two basic considerations. First, it doubted that the legitimate need of a private operator to make a profit, and the need to devote system revenues to the support of programming and public services, could be sufficiently reconciled. Second, public financing would entail lower interest rates for the borrowing of money, which in turn would have a substantial impact on the level of subscribers' fees and the amounts of money that would be available for the support of public uses of the system.[33]

The issues involved in municipal ownership are many and complex. As with the common carrier issue, the question of municipal ownership has created some unusual alliances. Those who view it with caution or opposition include: many black leaders, who would prefer franchising arrangements that cause commercial profits to accrue to black communities; the cable industry, for whom every municipally-owned system removes one community from the total number in which private operators can be franchised; and civil libertarians, who fear that municipal ownership could entail municipal control of content.[34] Those who believe that municipal ownership should be considered in urban centers include the Ford Foundation, the Corporation for Public Broadcasting, and Publi-Cable.[35]

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[33] Cable Television in Detroit: A Study in Urban Communications. Report Prepared by the Cable TV Study Committee for Common Council, City of Detroit, May 1972. $5.00. Copies available from City Clerk's Office, 1304 City County Bldg., Detroit, Michigan 48226 (checks payable to Cable TV Study Committee).

MITRE believes that some form of municipal or public interest ownership of cable systems should be seriously considered in urban centers. The advantages of lower interest rates for financing, of diversion of revenues generated by the system for public and civic uses of the system, and of overall direction of the system's operations in the public interest, are important and in some instances could be decisive. In MITRE's opinion, threats to civil liberties inherent in ownership by a public authority could be reduced or eliminated by turning over substantial operating authority, and decision-making on programming, to boards representing community subscribers or community groups, and by assuring constant availability of public access channels and channels available for lease at modest rates. MITRE sees no reason to think that a public authority would necessarily be less efficient in its business operations than a private franchisee; the Port of New York Authority, COMSAT, and a number of other public and quasi-public authorities would appear to provide evidence to the contrary. For that reason, as indicated in Section I, MITRE has proposed for consideration by Washington and other urban centers, operation of urban cable systems by a public interest authority or quasi-public interest corporation.

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[34] Charles Tate, Ed., Cable Television in the Cities, p. 36; CATV; various articles, June 23, 1969, December 21, 1970, January 11, 1971, May 24, 1971; Jerrold N. Oppenheim, "City-owned cable systems," Chicago Journalism Review, June 1972.

[35] FCC Docket 18892, Comments of the Ford Foundation, December 7, 1970; "Macy Urges Quick Action by Mayors on Cable Television," Corporation for Public Broadcasting release, December 1970; Publi-Cable, Inc., "Position Paper on Public Issues in Cable Communications," n.d. (November 1971). The Ford Foundation cautions that, for municipal ownership to be successful in the achievement of public interest objectives, cities must treat cable "as a new communications resource for the community" rather than a "new form of revenue for the city treasury," and warns that, to avert dangers in municipal control of a powerful communications medium, municipalities "should be required to divest themselves of control over channels reserved for community programming."

APPENDIX D

LIST OF INTERVIEWEES

NAME & TITLE	ORGANIZATION & ADDRESS
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NAME & TITLE	ORGANIZATION & ADDRESS
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